

# **San Juan Lateral Pumping Plants No. 4 and No. 7**

**Navajo-Gallup Water Supply Project  
New Mexico**

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**SECTION B – SUPPLIES OR SERVICES AND PRICES**  
**NAVAJO-GALLUP WATER SUPPLY PROJECT**  
**SAN JUAN LATERAL**  
**PUMPING PLANTS NO. 4 AND NO. 7**  
**NEW MEXICO**

**B.1 PRICE SCHEDULES**

- (a) Offers will be considered for award on the following Price Schedules, but no offer will be considered for award on only part of the Price Schedules.
- (b) Offers are subject to the terms and conditions of this solicitation.
- (c) Quantities in Price Schedules are estimated quantities for comparison of offers only. Except as provided in contract clause at FAR 52.211-18, Variation in Estimated Quantity, no claim shall be made against Government for overruns or underruns. Contract clause at FAR 52.211-18, Variation in Estimated Quantity does not apply to lump sum items.
- (d) See contract clause at WBR 1452.232-81, Payment for Mobilization and Preparatory Work, for CLIN 1-1 and 2-1.
- (e) Definitions:
  - (1) CLIN – Contract Line Item Number
- (f) Note: In accordance with Section 7-9-3.3 of New Mexico Statutes Annotated (NMSA) 1978 and Section 402 of Navajo Nation’s Business Activity Tax Statute, it is Contractor’s responsibility to ensure that all applicable New Mexico Gross Receipts Tax and Navajo Nation Gross Receipts Tax are included in their price proposal.
- (g) In accordance with FAR 52.232-5 (Payments under Fixed-Price Construction Contracts) (b)(2), payment may be approved for materials delivered to Contractor at locations other than the site if Contractor obtains CO approval prior to making arrangements for obtaining the materials. Contractor shall also be required to complete a “Materials on Hand Certificate” which will certify:
  - (1) Materials described for use on identified contract.
  - (2) Materials are clearly marked to identify that they belong to contract cited.
  - (3) Full title for those materials are vested in Prime Contractor sited.
  - (4) Materials are free of liens and encumbrances.
  - (5) Materials are properly store, secured, and protected against loss or damage.

## PRICE SCHEDULE 1 (Pumping Plant No. 4)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
1-1	WBR 1452.232 -81	Mobilization and Preparatory Work	For the lump sum of		\$
1-2	01 31 30	Contract Document Management System	For the lump sum of		\$
1-3	01 33 26	Electrical Drawings and Data	For the lump sum of		\$
1-4	01 56 15	Underground Utility Line Investigations	For the lump sum of		\$
1-5	01 56 15	Power Pole Relocation and/or Monitoring During Construction	4 each	\$	\$
1-6	01 78 30	As built and Final Drawings	1 each	<del>\$65,000</del> <del>25,000</del>	<del>\$65,000</del> <del>25,000</del>
1-7	01 78 30	Operations and Maintenance (O&M) Manuals PP No. 4	1 each	<del>\$65,000</del> <del>25,000</del>	<del>\$65,000</del> <del>25,000</del>
1-8	01 80 15	Commissioning	For the lump sum of		\$
1-9	03 20 00	Concrete Reinforcing	114,000 lb	\$	\$
1-10	03 30 00	Pumping Plant Concrete	755 yd <sup>3</sup>	\$	\$
1-11	03 30 00	Turnout Building Concrete	56 yd <sup>3</sup>	\$	\$
1-12	03 30 00	Chemical Building Concrete	53 yd <sup>3</sup>	\$	\$
1-13	03 35 10	Concrete Floor Hardener	7,400 ft <sup>2</sup>	\$	\$
1-14	03 48 00	Plant-Precast Concrete Structures	For the lump sum of		\$
1-15	04 22 10	Reinforced Concrete Unit Masonry Assemblies	For the lump sum of		\$
1-16	05 21 00	Steel Joists	For the lump sum of		\$
1-17	05 30 00	Metal Roof Deck	For the lump sum of		\$
1-18	05 50 00	Metal Fabrications	For the lump sum of		\$

## PRICE SCHEDULE 1 (Pumping Plant No. 4)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
1-19	06 82 10	Fiberglass Reinforced Plastic (FRP) Fabrications	For the lump sum of		\$
1-20	07 19 20	Silane Water Repellent	For the lump sum of		\$
1-21	10 14 00	Signage	For the lump sum of		\$
1-22	10 14 01	Entry Sign	For the lump sum of		\$
1-23	10 44 20	Fire Extinguishers	For the lump sum of		\$
1-24	10 51 00	Lockers	For the lump sum of		\$
1-25	13 34 21	Metal Building System	For the lump sum of		\$
1-26	21 22 00	Clean Agent Fire Extinguishing System	For the lump sum of		\$
1-27	22 11 10	Plant Auxiliary Water Systems	For the lump sum of		\$
1-28	22 13 16	Plant Gravity Drainage Piping Systems	For the lump sum of		\$
1-29	22 14 30	Sump Pumping Systems	For the lump sum of		\$
1-30	22 45 00	Emergency Plumbing Fixtures	For the lump sum of		\$
1-31	23 00 00	Heating, Ventilating, and Air-Conditioning (HVAC) System	For the lump sum of		\$
1-32	25 00 01	System Control and Monitoring	For the lump sum of		\$
1-33	26 05 10	Conductors and Cables	26,530 lin ft	\$	\$
1-34	26 05 13	Medium-Voltage Power Cable System	2,550 lin ft	\$	\$
1-35	26 05 13	Medium-Voltage Power Cable Accessories	For the lump sum of		\$
1-36	26 05 20	Ground Cable	1,950 lin ft	\$	\$
1-37	26 05 20	Ground Rods	11 each	\$	\$

## PRICE SCHEDULE 1 (Pumping Plant No. 4)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
1-38	26 05 20	Electrical Ground Resistance Test	For the lump sum of		\$
1-39	26 05 33	Electrical Conduit	8,220 lin ft	\$	\$
1-40	26 05 33	Fabricated Sheet Steel Boxes, Wiring Troughs, and Precast Handholes	For the lump sum of		\$
1-41	26 05 36	Cable Trays	460 lin ft	\$	\$
1-42	26 12 19	Pad Mounted Transformer	For the lump sum of		\$
1-43	26 17 20	Metal-Clad Switchgear Assembly	For the lump sum of		\$
1-44	26 18 39	Medium-Voltage Motor Controllers	For the lump sum of		\$
1-45	26 22 12	Dry-Type Transformer	For the lump sum of		\$
1-46	26 24 13	Switchboards	For the lump sum of		\$
1-47	26 24 41	Distribution Panelboards	For the lump sum of		\$
1-48	26 26 10	Transformer Load Center	For the lump sum of		\$
1-49	26 27 40	Wiring Devices	For the lump sum of		\$
1-50	26 32 10	Diesel Engine-Generator Set (Pumping Plant No. 4)	For the lump sum of		\$
1-51	26 42 10	Corrosion Monitoring Systems	For the lump sum of		\$
1-52	26 42 11	Submerged Galvanic Anode Cathodic Protection System for Welded Tank Option	For the lump sum of		\$
1-53	26 42 12	Submerged Galvanic Anode Cathodic Protection System for Bolted Steel Tank Option	For the lump sum of		\$
1-54	26 51 00	Interior Lighting	For the lump sum of		\$
1-55	26 52 00	Emergency and Exit Lighting	For the lump sum of		\$

## PRICE SCHEDULE 1 (Pumping Plant No. 4)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
1-56	26 56 00	Exterior Lighting	For the lump sum of		\$
1-57	27 30 01	Telephone System	For the lump sum of		\$
1-58	28 10 01	Security and Surveillance System	For the lump sum of		\$
1-59	28 31 00	Fire Detection and Alarm	For the lump sum of		\$
1-60	31 02 10	Water for Dust Abatement	1,200 MGal	\$	\$
1-61	31 02 30	Dust Palliative	8.6 Acre	\$	\$
1-62	31 23 10	Common Excavation for Structures	12,900 yd <sup>3</sup>	\$	\$
1-63	31 23 10	Compacted Backfill for Structures	8,600 yd <sup>3</sup>	\$	\$
1-64	31 23 10	Processing Foundation Materials	8,600 yd <sup>3</sup>	\$	\$
1-65	31 23 50	Earthwork for Roads	23,500 yd <sup>3</sup>	\$	\$
1-66	31 24 18	Gravel Drain Material for <del>Water Storage Tank Concrete Tank and Bolted Steel Tank Options</del>	550 yd <sup>3</sup>	\$	\$
1-67	31 32 36	HDPE Geomembrane for <del>Water Storage Tank Concrete Tank and Bolted Steel Tank Options</del>	950 yd <sup>2</sup>	\$	\$
1-68	32 12 22	Asphalt Concrete Pavement	29 ton	\$	\$
1-69	32 15 10	Gravel Surfacing	2,400 yd <sup>3</sup>	\$	\$
1-70	32 15 11	Aggregate Base	54 ton	\$	\$
1-71	32 17 20	Traffic Lines and Markings	For the lump sum of		\$
1-72	32 31 01	Fence Grounding	For the lump sum of		\$
1-73	32 31 10	Chain Link Fence	1,312 lin ft	\$	\$

## PRICE SCHEDULE 1 (Pumping Plant No. 4)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
1-74	32 91 60	Erosion Control Blanket	1,750 yd <sup>2</sup>	\$	\$
1-75	33 09 13	Pressure Differential Flowmeter Systems	For the lump sum of		\$
1-76	33 09 15	Flood Detection and Alarm System	For the lump sum of		\$
1-77	33 11 10	Line Pipe, Reach 7	1,772 lin ft	\$	\$
1-78	33 11 10	Sheep Spring Turnout	2,193 lin ft	\$	\$
1-79	33 11 10	Pumping Plant No. 4 Tank Drain	350 lin ft	\$	\$
1-80	33 11 10	Temporary 6-inch Construction Waterline	2,516 lin ft	\$	\$
1-81	33 11 15	PVC Pipe Drains for <u>Water Storage Tank Concrete Tank and Bolted Steel Tank Options</u>	290 lin ft	\$	\$
1-82	33 11 16	Site Water Utility Piping	For the lump sum of		\$
1-83	33 12 71	Vertical Pumping Units	For the lump sum of		\$
1-84	33 16 14	Air Chambers and Air Compressors	For the lump sum of		\$
1-85	33 16 40	Water Storage Tanks	For the lump sum of		\$
1-86	33 42 30	36-inch Corrugated Metal Pipe Culvert	60 lin ft	\$	\$
1-87	35 21 95	Steel Manifold Piping	For the lump sum of		\$
1-88	35 22 14	Valves and Equipment	For the lump sum of		\$
1-89	46 33 00	Chlorine Disinfection System	For the lump sum of		\$

TOTAL FOR PRICE SCHEDULE 1 \$ \_\_\_\_\_

## PRICE SCHEDULE 2 (Pumping Plant No. 7)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
2-1	WBR 1452.232- 81	Mobilization and Preparatory Work	For the lump sum of		\$
2-2	01 31 30	Contract Document Management System	For the lump sum of		\$
2-3	01 33 26	Electrical Drawings and Data	For the lump sum of		\$
2-4	01 56 15	Underground Utility Line Investigations	For the lump sum of		\$
2-5	07 78 30	As built and Final Drawings	1 each	<u>\$65,000</u> <u>25,000</u>	<u>\$65,000</u> <u>25,000</u>
2-6	01 78 30	Operations and Maintenance (O&M) Manuals PP No. 7	1 each	<u>\$65,000</u> <u>25,000</u>	<u>\$65,000</u> <u>25,000</u>
2-7	01 80 15	Commissioning	For the lump sum of		\$
2-8	03 20 00	Concrete Reinforcing	109,000 lb.	\$	\$
2-9	03 30 00	Pumping Plant Concrete	770 yd <sup>3</sup>	\$	\$
2-10	03 30 00	Turnout Building Concrete	56 yd <sup>3</sup>	\$	\$
2-11	03 35 10	Concrete Floor Hardener	7,400 ft <sup>2</sup>	\$	\$
2-12	03 48 00	Plant-Precast Concrete Structures	For the lump sum of		\$
2-13	04 22 10	Reinforced Concrete Unit Masonry Assemblies	For the lump sum of		\$
2-14	05 21 00	Steel Joists	For the lump sum of		\$
2-15	05 30 00	Metal Roof Deck	For the lump sum of		\$
2-16	05 50 00	Metal Fabrications	For the lump sum of		\$
2-17	06 82 10	Fiberglass Reinforced Plastic (FRP) Fabrications	For the lump sum of		\$
2-18	07 19 20	Silane Water Repellent	For the lump sum of		\$
2-19	10 14 00	Signage	For the lump sum of		\$
2-20	10 14 01	Entry Sign	For the lump sum of		\$
2-21	10 44 20	Fire Extinguishers	For the lump sum of		\$
2-22	10 51 00	Lockers	For the lump sum of		\$
2-23	13 34 21	Metal Building System	For the lump sum of		\$
2-24	21 22 00	Clean Agent Fire Extinguishing Systems	For the lump sum of		\$
2-25	22 13 16	Plant Gravity Drainage Piping Systems	For the lump sum of		\$

## PRICE SCHEDULE 2 (Pumping Plant No. 7)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
2-26	22 14 30	Sump Pumping Systems	For the lump sum of		\$
2-27	23 00 00	Heating, Ventilating, and Air-Conditioning (HVAC) System	For the lump sum of		\$
2-28	25 00 01	System Control and Monitoring	For the lump sum of		\$
2-29	26 05 10	Conductors and Cables	25,776 lin ft	\$	\$
2-30	26 05 13	Medium-Voltage Power Cable System	2,550 lin ft	\$	\$
2-31	26 05 13	Medium-Voltage Power Cable Accessories	For the lump sum of		\$
2-32	26 05 20	Ground Cable	1,950 lin ft	\$	\$
2-33	26 05 20	Ground Rods	11 each	\$	\$
2-34	26 05 20	Electrical Ground Resistance Test	For the lump sum of		\$
2-35	26 05 33	Electrical Conduit	8,120 lin ft	\$	\$
2-36	26 05 33	Fabricated Sheet Steel Boxes, Wiring Troughs, and Precast Handholes	For the lump sum of		\$
2-37	26 05 36	Cable Trays	460 lin ft	\$	\$
2-38	26 12 19	Pad Mounted Transformer	For the lump sum of		\$
2-39	26 17 20	Metal-Clad Switchgear Assembly	For the lump sum of		\$
2-40	26 18 39	Medium-Voltage Motor Controllers	For the lump sum of		\$
2-41	26 22 12	Dry-Type Transformer	For the lump sum of		\$
2-42	26 24 13	Switchboards	For the lump sum of		\$
2-43	26 24 41	Distribution Panelboards	For the lump sum of		\$
2-44	26 27 40	Wiring Devices	For the lump sum of		\$
2-45	26 32 10	Diesel Engine-Generator Set at Pumping Plant No. 7	For the lump sum of		\$
2-46	26 42 10	Corrosion Monitoring Systems	For the lump sum of		\$
2-47	26 42 11	Submerged Galvanic Anode Cathodic Protection System for Welded Tank Option	For the lump sum of		\$
2-48	26 42 12	Submerged Galvanic Anode Cathodic Protection System for Bolted Steel Tank Option	For the lump sum of		\$

## PRICE SCHEDULE 2 (Pumping Plant No. 7)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
2-49	26 51 00	Interior Lighting	For the lump sum of		\$
2-50	26 52 00	Emergency and Exit Lighting	For the lump sum of		\$
2-51	26 56 00	Exterior Lighting	For the lump sum of		\$
2-52	27 30 01	Telephone System	For the lump sum of		\$
2-53	28 10 01	Security and Surveillance System	For the lump sum of		\$
2-54	28 31 00	Fire Detection and Alarm	For the lump sum of		\$
2-55	31 02 10	Water for Dust Abatement	1,000 MGal	\$	\$
2-56	31 02 30	Dust Palliative	3.9 Acre	\$	\$
2-57	31 23 10	Common Excavation for Structures	11,500 yd <sup>3</sup>	\$	\$
2-58	31 23 10	Rock Excavation for Structures	2,290 yd <sup>3</sup>	\$	\$
2-59	31 23 10	Compacted Backfill for Structures	8,000 yd <sup>3</sup>	\$	\$
2-60	31 23 10	Processing Foundation Materials	8,000 yd <sup>3</sup>	\$	\$
2-61	31 23 50	Earthwork for Roads	1,480 yd <sup>3</sup>	\$	\$
2-62	31 24 18	Gravel Drain Material for <del>Concrete Tank and Bolted Steel Tank</del> Options	910 yd <sup>3</sup>	\$	\$
2-63	31 32 36	HDPE Geomembrane for <del>Concrete Tank and Bolted Steel Tank</del> Options	1,500 yd <sup>2</sup>	\$	\$
2-64	32 12 22	Asphalt Concrete Pavement	29 ton	\$	\$
2-65	32 15 10	Gravel Surfacing	2,040 yd <sup>3</sup>	\$	\$
2-66	32 15 11	Aggregate Base	54 ton	\$	\$
2-67	32 17 20	Traffic Lines and Markings	For the lump sum of		\$
2-68	32 31 01	Fence Grounding	For the lump sum of		\$
2-69	32 31 10	Chain Link Fence	1,375 lin ft	\$	\$
2-70	32 31 70	Cattle Guards	65 lin ft	\$	\$
2-71	32 91 60	Erosion Control Blanket	4,700 yd <sup>2</sup>	\$	\$
2-72	33 09 13	Pressure Differential Flowmeter Systems	For the lump sum of		\$

## PRICE SCHEDULE 2 (Pumping Plant No. 7)

CLIN	Section	Supplies or Services	Quantity and Unit	Unit Price	Amount
2-73	33 11 15	PVC Pipe Drains for <i>Water Storage Tank</i> <del>Concrete Tank and Bolted Steel Tank Options</del>	360 lin ft	\$	\$
2-74	33 11 16	Site Water Utility Piping	For the lump sum of		\$
2-75	33 12 71	Vertical Pumping Units	For the lump sum of		\$
2-76	33 16 14	Air Chambers and Air Compressors	For the lump sum of		\$
2-77	33 16 40	Water Storage Tanks	For the lump sum of		\$
2-78	35 21 95	Steel Manifold Piping	For the lump sum of		\$
2-79	35 22 14	Valves and Equipment	For the lump sum of		\$
2-80	46 33 00	Mixer	For the lump sum of		\$

TOTAL FOR PRICE SCHEDULE 2 \$ \_\_\_\_\_

**END OF SUPPLIES OR SERVICES AND PRICES**

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**SECTION 01 11 00**  
**SUMMARY OF WORK**

**PART 1 GENERAL**

**1.01 LOCATION**

A. Pumping Plant No. 4:

1. Work is located approximately 47 miles north of Gallup, NM and 41 miles south of Shiprock, NM in San Juan County. Project is on the east side of U.S. Highway 491.

B. Pumping Plant No. 7:

1. Work is located approximately 15 miles north of Gallup, NM and 71 miles south of Shiprock, NM in McKinley County. Project is east of U.S. Highway 491 on the north side of BIA Route 9.

**1.02 PRINCIPAL COMPONENTS OF WORK**

A. Construct Pumping Plant No. 4 and the following components:

- a. Access Road.
- b. Metal Building.
- c. Vertical Centrifugal Can-Type Pumps.
- d. Steel Manifold Piping.
- e. Air Chambers.
- f. Electrical System.
- g. Water Storage Tank.
- h. Chemical Building.
- i. SCADA System.

B. Construct Pumping Plant No. 7 and the following components:

- a. Access Road.
- b. Metal Building.
- c. Vertical Centrifugal Can-Type Pumps.
- d. Steel Manifold Piping.
- e. Air Chambers.
- f. Electrical System.

- g. Water Storage Tank.
- h. SCADA System.

- C. Use the same model and manufacturer for products with the same function and capacity at both pumping plants.
- D. Use the same manufacturer for products with the same function and different capacity at both pumping plants.

### **1.03 SPECIFICATIONS REQUIREMENTS**

- A. Requirements in Division 1 and General Requirements apply to Divisions 2 through 53.
- B. Imperative statements in these specifications are Contractor requirements, unless otherwise stated.
- C. Where specifications are written in streamlined form, the words “shall be” are included by inference where a colon (:) is used within sentence or phrase.

### **1.04 DEFINITIONS**

- A. When specifications use a word or term defined in Federal Acquisition Regulations (FAR), definition of word or term shall be in accordance with FAR sections in effect at time solicitation was issued.

### **1.05 ACRONYMS**

- A. Following acronyms apply to specifications Divisions 1 through 53:
  - 1. CO: Contracting Officer.
  - 2. COR: Contracting Officer’s Representative.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 14 10**  
**USE OF SITE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. Bureau of Reclamation (Reclamation)

1. Cleaning Manual                      Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species (Technical Memorandum No. 86-68220-07-05) 2012 Edition. Available online at:  
[www.usbr.gov/mussels/prevention](http://www.usbr.gov/mussels/prevention)

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 01 14 10-1, Land Use and Landscape Rehabilitation Plan:

1. Use site on ROW or easements:
  - a. Show use location and extent of impact. Uses include but are not limited to the following:
    - 1) Buildings and service areas including onsite offices, shops, warehouses, storage areas, fuel and oil storage areas, and fabrication yards.
    - 2) Parking areas, temporary roads, and haul routes.
    - 3) Utilities including gas, air, power, and water lines; fire hydrants; and compressor station.
    - 4) First-aid and medical facilities.
    - 5) Concrete, CLSM and aggregate plants. Show sizes, rated capacities, and general features of aggregate processing plant including transporting, storing, screening, and washing facilities; concrete batching and mixing plant; and concrete conveying, placing, and concrete washouts.
    - 6) Areas for processing, storing, and disposing of waste materials from construction operations.

- 7) Temporary fences.
- 8) Utility hook-ups for Reclamation construction trailer.
- b. Describe methods to preserve, protect, and repair, vegetation (such as trees, shrubs, and grass) and other landscape features on or adjacent to jobsite, which are not to be removed and which do not interfere with work required under this contract. Include methods to mark work area limits, protect disturbed areas, and prevent erosion.
- c. Describe methods to protect, and repair, existing improvements and utilities at or near jobsite.
- d. Describe methods for removing temporary structures and facilities, cleanup, and rehabilitating site after completion of construction activities.
- 2. Submit revised drawings of changes in use of Federal land made during design and erection stages or after use of Federal land is in operation.

#### **1.04 PROJECT CONDITIONS**

- A. ROW or Easements as shown on drawings may be used for required construction facilities:
  - 1. Refer to Staging Area drawing for approved location of construction trailers.
  - 2. Include space and hookups for Government construction trailers.
- B. When private land is used for construction facilities, or other construction purposes, make necessary arrangements associated with use of private land:
  - 1. Prior to using land outside of ROW, obtain cultural and environmental approvals in accordance with Section 01 31 19 – Project Management and Coordination.
- C. Location, construction, operation, maintenance, and removal of construction facilities on ROW or Easements will be subject to approval of COR.
- D. Do not interfere with work of other contractors, Navajo Nation and/or Government in vicinity, or with reservations made by Government for use of such land.
- E. See 01 51 00 – Temporary Utilities.
- F. Housing for construction personnel will not be permitted.
- G. Natural Conditions:
  - 1. Pumping Plant No. 4:
    - a. Ambient Temperature Range: -20 to 100 degrees F.
    - b. Annual Average Precipitation: 11.54-inches.
    - c. Altitude: 5,867.5-feet.

- d. Wind:
  - 1) Maximum sustained: 40.8 knots.
  - 2) Maximum gust: 60.8 knots.
- 2. Pumping Plant No. 7:
  - a. Ambient Temperature Range: -20 to 100 degrees F.
  - b. Annual Average Precipitation: 11.54-inches.
  - c. Altitude: 6,215-feet.
  - d. Wind:
    - 1) Maximum sustained: 40.8 knots.
    - 2) Maximum gust: 60.8 knots.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 CLEANING**

- A. Construction Equipment:
  - 1. In accordance with Cleaning Manual.
  - 2. Before bringing on site, clean construction equipment to remove dirt, vegetation, and other organic material to prevent introduction of noxious weeds, and invasive plant and animal species.
  - 3. Contractor cleaning procedures shall result in equipment and vehicles being cleaned as well or better than procedures described in Cleaning Manual.
  - 4. COR will inspect construction equipment following procedures described in Cleaning Manual before allowing equipment onsite.

### **3.02 RESTORATION**

- A. Restore Contractor use areas to pre-construction condition.
- B. Restore temporary construction roads to original contours and make impassable to vehicular traffic when no longer required.
- C. After completion of work, regrade and scarify Easements and ROWs used for construction purposes and not required for completed installation so that surfaces blend with natural terrain and are in a condition that will facilitate revegetation, provide proper drainage, and prevent erosion.

**END OF SECTION**

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**SECTION 01 31 19**  
**PROJECT MANAGEMENT AND COORDINATION**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. Bureau of Reclamation (Reclamation)

1. RSHS Reclamation Safety and Health Standards including revisions posted at:  
[www.usbr.gov/ssle/safety/RSHS/rshs.html](http://www.usbr.gov/ssle/safety/RSHS/rshs.html)
2. Navajo OSHA Navajo OSHA, Sawnevan Dale;  
(928) 871-6742 [sdale@nmosha.org](mailto:sdale@nmosha.org)

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 01 31 19-1, Pre-Design Electrical Coordination Meeting Notifications:

1. Provide confirmation to COR regarding requested date and time of meetings and indicate who will attend and affiliation.
2. See Section 25 00 01 – System Control and Monitoring for Design Coordination Meeting sequence.
3. Provide copies of preliminary drawings.

C. RSN 01 31 19-2, Written Summary:

1. Written weekly summary of upcoming work, traffic plans and progress meeting minutes. Provide work schedule for next 3-weeks including list of RSNs and RFIs.

D. RSN 01 31 19-3, Off ROW Land Use Coordination:

1. Show expanded use location and extent of impact.
2. Request cultural approvals:
  - a. In accordance with Section 01 57 90 – Preservation of Historical and Archeological Data.

3. Request or revise Environmental Permits in accordance with:
  - a. Section 01 57 20 – Environmental Controls.
  - b. Section 01 57 30 – Water Pollution Control.
  - c. Section 01 57 50 – Tree and Plan Protection.
  - d. Section 01 57 60 – Protected Species.
4. Do not use proposed land until approved by COR:
  - a. Approvals may require up to 6-months.
5. Requirement does not apply to existing commercial facilities.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 PROJECT COORDINATION**

- A. Coordinate work with COR, other Bureau of Reclamation (Reclamation) staff, Bureau of Indian Affairs, and other Federal, State and local Agencies as needed.
- B. Facilitate onsite work with above listed agencies.
- C. 48-Hour Look Ahead Notification:
  1. Provide COR, via email, and phone with a 48-hour notice when Cultural Resource Contractor is required. Contact information will be provided at preconstruction meeting.

### **3.02 MEETINGS**

- A. The following meetings are considered significant, but do not relieve Contractor from responsibility of other meetings required by specifications.
  1. Pre-Design Coordination Conference:
    - a. Contractor and subcontractors' technical engineering representatives responsible for submitting, reviewing, purchasing, and installing Pumps, HVAC, Electrical, Architectural, Plumbing, Chlorination Systems, SCADA and Communications shall attend pre-design coordination conference prior to submitting approval data and drawings.
    - b. Technical representatives to be fully informed of equipment specification requirements and coordination required between various equipment manufacturers.

- c. Conference to occur within 45-days following receipt of Notice to Proceed and will be scheduled by COR.
  - d. Conference Location: Four Corners Construction Office, 1235 LaPlata Highway, Farmington, New Mexico; or site agreed upon by Contractor and COR.
2. Submittal Comment and Review Conference:
- a. Contractor and subcontractors' technical staff responsible for submitting, reviewing, purchasing, and installing Pumps, HVAC, Electrical, Architectural, Plumbing, and Chlorination Systems shall attend a submittal comment and review conference prior to performing any manufacturing and within 20-days following Government's mailing of response to RSN's titled, "Approval Drawings and Manufacturer's Data (manufacturer's technical catalog data, equipment layout, bill of material, nameplate list, schematic diagrams, and sample wiring and interconnection diagrams)".
  - b. Approval Drawing and Manufacturer's Data submittals are due no later than date listed in Section 01 33 00 – Submittals, Table 01 33 00A – List of Submittals.
  - c. It is intended to conduct this conference within 20-days following Government's review of all Approval Submittals for equipment listed above. Conference will be scheduled by COR.
  - d. Contractor is responsible for all construction schedule impacts due to incomplete submittals and late submittals.
  - e. It is intended to discuss in detail Government's review comments for Approval Submittals described above.
  - f. Conference Location: Four Corners Construction Office, 1235 LaPlata Highway, Farmington, New Mexico; or a site agreed upon by Contractor and COR.
3. Pre-Construction Meeting:
- a. Meet with Government prior to start of construction. Contractor shall provide as minimum Project Manager or Project Superintendent for Preconstruction Meeting. Review will include, but may not be limited to:
    - 1) Use of ROW by Contractor, Government, and public:
      - a) Off ROW land use coordination.
    - 2) Construction facilities and controls.
    - 3) Access to work and haul routes.
    - 4) Temporary utilities.
    - 5) Survey layout.
    - 6) Security.
    - 7) Housekeeping procedures.

- 8) Schedules and sequence of work.
  - 9) Procedures for testing.
  - 10) Procedures for maintaining record documents.
  - 11) Special site requirements:
    - a) Archeological: Refer to Section 01 57 90 – Preservation of Historical and Archaeological Data.
    - b) Biological: Refer to Section 01 57 60 – Protected Species.
    - c) Environmental: Refer to:
      - i. Section 01 57 20 – Environmental Controls
      - ii. Section 01 57 30 – Water Pollution Control.
  - 12) Roles and responsibilities:
    - a) Government organization and personnel.
    - b) Contractor organization and personnel.
    - c) Subcontractors.
    - d) Proposed work schedule.
  - 13) Contract requirements:
    - a) Progress payments.
    - b) Invoices.
    - c) Differing site conditions.
    - d) Changes.
    - e) Superintendence by Contractor.
    - f) Payment for mobilization and preparatory work.
    - g) Submittal procedures.
    - h) Emails, faxes, and telephone calls.
4. Pre-Construction Safety Meeting:
- a. Meet with COR prior to start of construction.
  - b. Review will include:
    - 1) Safety requirements.
    - 2) Monthly joint safety policy meetings.
    - 3) Weekly toolbox safety meetings.
    - 4) Safety program.
    - 5) Job hazard analysis.
    - 6) Required safety inspections.

- 7) Government will monitor Contractor's operations for compliance with RSHS.
5. Progress Meetings:
- a. Meet weekly with Government to review:
    - 1) Progress made.
    - 2) Review As-built drawings.
    - 3) Difficulties in performing work.
    - 4) Resolution necessary to meet specifications requirements.
    - 5) Status of contract documents (RFI's, submittals, etc.).
    - 6) Three-week look ahead.
    - 7) Updating of progress reports.
    - 8) Other items as determined by COR.
  - b. Develop meeting agenda and minutes, may be used as Written Summary.

**END OF SECTION**

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**SECTION 01 31 30**  
**CONTRACT DOCUMENT MANAGEMENT SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Contract Document Management System:
1. Payment: Lump sum price offered in the Price Schedules.

**1.02 DEFINITIONS**

- A. CDMS: Contract Document Management System:
1. Contract Documents include, but are not limited to:
    - a. Specifications.
    - b. Contract Drawings.
    - c. Submittals.
    - d. RFIs: Request for Information (Contractor generated document).
    - e. RFPs: Request for Proposal (Reclamation generated document).
    - f. CMs: Contract Modifications.
    - g. Contractor Proposals.
    - h. Value Engineering Proposals.
    - i. Bureau of Reclamation (Reclamation) Inspection Reports.
    - j. DIR: Daily Inspection Reports.
    - k. Invoices and Progress Payments.
    - l. Contract Schedules.
    - m. Meeting Agendas and Meeting Minutes.
    - n. Letters and Memos.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 31 30-1, Approval Data:
1. Documentation of system capabilities.
  2. Instructions for system use.

- C. RSN 01 31 30-2, Final Data:
  - 1. DVD or CD with all uploads to CDMS as available.

#### **1.04 QUALIFICATIONS**

- A. System Provider: At least 5-years successful performance in providing required services.

#### **1.05 CDMS REQUIREMENTS**

- A. CDMS shall be capable of generating, storing, tracking, categorizing, and managing Contract Documents.
- B. Access:
  - 1. Web-based:
    - a. Contract Documents are stored and accessed by authorized individuals via an internet site.
    - b. Compatible with web browsers MS Internet Explorer, Apple Safari, and Mozilla Firefox, Google Chrome.
  - 2. Ability to upload Contract Documents and make available for user download in the following supported file formats, minimum:
    - a. Adobe Acrobat.
    - b. MS Word.
    - c. MS Excel.
    - d. MS Project.
    - e. Oracle Primavera P6 Project Manager.
    - f. AutoCAD Civil 3D Version 2018.
    - g. Contract Manager.
  - 3. Allow Contract Documents to be prepared by Contractor or by Government:
    - a. Preparing organization will control access of documents. See Document Security and Backup paragraph below.
  - 4. Contractor and Government shall each have a project manager for CDMS:
    - a. Each project manager shall have capabilities to assign users within their organization and to assign user rights which control access to documents based on user class and document type.
    - b. Each organization shall be capable of defining its access hierarchy.
    - c. Inclusion of users will be prerogative of organizational project manager.
    - d. Government project manager shall be able to create and modify project properties (i.e., Contractor, project location, description, bid amount, project directory, etc.).

5. Email notifications shall be automatically sent to selectable users when new documents are submitted and available for viewing, or alerts are generated. Examples include:
    - a. Updates to project information (e.g., entry of a new submittal);
    - b. Changes to project information (e.g., approval of a submittal);
    - c. Alerts (e.g., submittal under review for >15-days without action).
  6. Ability to link files; examples include:
    - a. RFP linked to a CM.
    - b. Submittal linked to a Specification or Drawing.
- C. Reports:
1. CDMS shall:
    - a. Generate reports that list and sort documents by status; examples include:
      - 1) Submittals that have been approved.
      - 2) Invoices paid to date.
      - 3) RFIs under review.
    - b. Generate alerts when documents requiring action approach or exceed allowable time.
    - c. Generate customizable summary reports; examples include:
      - 1) Submittal Turn-around.
      - 2) RFI Turn-Around.
      - 3) CM Processing Turn-Around.
      - 4) Total CM costs.
      - 5) Total CM Request Exposure.
    - d. Reports shall be printable, exportable as searchable .pdf or printer friendly .html, and exportable to Excel (.xls, .xml, or .csv).
    - e. Ability to link from an item in a report directly to item by clicking on it:
      - 1) For example: In submittal report, clicking on submittal that is 15-days old takes you directly to information on that submittal.
    - f. Capable of producing complete and logically organized set of documents within CDMS in both .pdf and .xml format.
- D. Document Security and Backup:
1. Secure Server Language (SSL) encryption for secured data exchange between browser and server (Secure access to documents and information).
  2. Allow document access security until authoring party chooses to share it with others:

- a. Show parties that have access to document.
  - b. Extent of document sharing shall be determined by authoring party.
  - c. Once documents are shared, track documents so that changes cannot occur without record of changes.
3. Backup/Archiving to FTP site of documents to which an organization has access on a regular (minimum monthly) basis. Backups shall be in .pdf format.
  4. Documents shall be downloadable to FTP sites where Government and other organizations can access their own data confidentially.
- E. General Tracking and Control:
1. Documents shall be grouped into categories (Submittals, RFI, RFP, CM, Payments, Daily Inspection Reports, and Meeting Minutes).
  2. CDMS shall track:
    - a. When documents were received or returned, as well as status of documents (e.g. Under Review; or Returned, Approved or Rejected, etc.).
    - b. Document changes including who entered or changed document and date change was made.
    - c. When a reviewer has opened an item.
- F. Submittal Tracking and Control:
1. Ability to create master list of submittals (“Schedule of Submittals”).
  2. Customizable standard submittal form for entering information:
    - a. Required submittal number (RSN), title, description, and specification section.
    - b. Upload submittal data in electronic format.
  3. Track date received, date response due, date returned, and status:
    - a. Status designations may be modified to fit Government standard designations – Approved, approved subject to identified changes, or not approved.
  4. Supply Submittal Tracking form for Government to enter review comments and action taken. Allow customizing of submittal tracking form:
    - a. Allow for Government to route submittal to third parties (e.g., consultant, internal design or operations and maintenance groups, etc.) by generating design-review transmittals with each submittal package item, to track status of individual sub-items within the submittal package, and to route each sub-item to appropriate reviewers.
  5. Ability to generate automatic notification after specified days without response.

G. RFI Tracking and Control:

1. Provide standard RFI form to enter information.
2. Ability to create or attach documents to the RFI form or links to other documents within CDMS.
3. Ability for Reclamation to route RFI to appropriate reviewers and for reviewers to enter comments into standard response form.

H. Inspection Reports Tracking and Control:

1. Ability to attach Government standard inspection and report forms into CDMS and ability to create customizable inspection forms in CDMS. Typical forms:
  - a. Daily Inspection Report (DIR).
  - b. Survey requests.
  - c. Plant inspection reports.
  - d. Testing reports.
2. Ability to link or attach photos to forms and link forms to other documents within CDMS.

I. Contract Modifications:

1. Supply standard Contractor Proposal form with ability to attach documents and link to other documents within CDMS.
2. Supply ability to upload Government's standard CM form and RFP forms, or create an acceptable alternative, to enter information.
3. Ability to attach documents to these forms, and link to other documents within CDMS.
4. Ability for Contractor to respond to RFP and CM form with Cost and Time impacts.
5. Ability to track date CM issued and date responded, with automatic notification after specified days without response.

J. Cost Tracking and Payment Request Management:

1. Ability to import payment bid items cost from a MS Excel spreadsheet.
2. Ability to edit percent complete and payment amount each month. Format to be spreadsheet, e.g. items available for editing at once, rather than needing to edit one item at a time, save, open next item and edit that, etc.

K. Correspondence:

1. Ability to generate letters and memos:
  - a. Ability to attach documents to letters and memos, and to reference other documents within CDMS.

- b. CDMS shall automatically assign sequential numbers to letters and memos.
  - 2. Ability to generate responses to letters and memos:
    - a. System automatically generates memo suffixes, e.g. the 1<sup>st</sup> response to Memo 32 to be 32.1, 2<sup>nd</sup> response to be 32.2, etc.
  - 3. Official correspondence from Government to Contractor shall contain Government's official letterhead and corresponding logos.
  - 4. Ability to generate meeting agendas and meeting minutes and to attach documents to the minutes:
    - a. CDMS shall automatically assign sequential meeting numbers.
- L. Miscellaneous Tracking and Controls:
  - 1. Ability to generate logs tracking RFIs, CORs, COs, Submittals, Payments, Memos, daily inspection reports, survey requests, plant inspection reports and testing reports.
  - 2. Ability to filter logs based on criteria e.g. for Submittals: Specification Section, Days Out, Status (approved, partially approved, approved subject to identified changes and resubmit, or not approved); for RFI's: Days out, Status (Open/Closed), Specification Section/Dwg. No., Responsibility/Ball-In-Court
  - 3. Ability to sort Logs based on a criteria, e.g., for Submittal, Specification Section, Days Out, Status, or other criteria determined by COR.
  - 4. Ability to provide forms to match Government's CM Form and Progress Payment Form or other forms when needed.
  - 5. Ability to track Cost Exposure with links to RFI and CM requests.
  - 6. Ability to measure productivity benchmarks on a project such as computing average review days for RFIs and submittals, categorize CMs, and track total CM percentages by category.
  - 7. Ability for keyword search of documents in database.
  - 8. Ability to allow online Payment Requests (electronic invoicing) by Contractor.
- M. Budget and Funding Source Tracking:
  - 1. Ability to enter funding sources and assign contract line items to multiple funding sources.

## **PART 2 PRODUCTS**

- A. Procore, as manufactured by Procore, [www.procore.com](http://www.procore.com), or equal with the following essential characteristics: Capable of performing requirements of Part 1 and Part 3.

## **PART 3 EXECUTION**

### **3.01 IMPLEMENTATION**

- A. CDMS shall be in place and operating within 45-days of Award:
  - 1. CDMS operation includes COR, or other authorized Government representative, having program control to assign users and user rights to Government personnel to access appropriate areas of system.
  
- B. Contractor shall input entrees to Schedule of Submittals before making submittals:
  - 1. Schedule of Submittals shall include RSNs listed in Table 01 33 00A - List of Submittals.
  - 2. Scheduled submittal date.
  
- C. Contractor shall provide a report of submittal status monthly or as requested by COR. Submittal status report:
  - 1. Be in a table format and include:
    - a. Required Submittal Number (RSN).
    - b. Section Title.
    - c. Submittal Title.
    - d. Date Submitted.
    - e. Date of Response.
    - f. Approval Status (approved, partially approved, approved subject to identified changes and resubmit, or not approved).
    - g. Days in Review.
    - h. Due Date.
  
- D. CDMS shall be operational until final project closeout.

**END OF SECTION**

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**SECTION 01 32 10**  
**CONSTRUCTION PROGRAM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Costs:

1. Developing Baseline Schedule: Include in lump sum prices offered in the Price Schedules for mobilization and preparatory work.
2. Updating and Using Construction Program: Include as an element of Contractor's overhead.

**1.02 DEFINITIONS**

- A. Schedule: Critical Path Method (CPM) of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and critical path of project.
- B. Project Calendar(s): Cross reference of numerical work days with calendar days. Project calendar serves as basis for day/date conversion and assigns work days and non-workdays.
- C. Resources: Equipment, labor or crews, materials, subcontractors, fabricators, manufacturers, and consultants.
- D. Out of Sequence Work: An activity that starts before its predecessor activities are completed.

**1.03 REFERENCE STANDARDS**

- A. Associated General Contractors of America (AGC)
1. AGC Manual-04 Construction Planning and Scheduling Manual, 2004

**1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals:
1. Furnish database files in format compatible with Oracle Primavera P6 Professional Project Management.
  2. Furnish schedule and analysis data via CDMS, DVD or USB drive.
  3. Upon request, provide information and data used to develop and maintain Construction Program to CO.

- B. RSN 01 32 10-1, Representative Information:
1. Designation of authorized representative to develop and maintain Construction Program. Include resume with training and experience.
- C. RSN 01 32 10-2, Baseline Schedule:
1. Include:
    - a. Construction Program/Schedule database.
    - b. Definition of project calendars.
    - c. Primavera layout file (.plf).
    - d. Gantt chart (Bar chart) for project on 11- by 17-inch prints and in portable document format (.pdf).
    - e. Activity report including logic constraints consisting of predecessors, successors, and constraint dates.
    - f. Tabular listings of resources and resource limitations used to produce baseline schedule. Correlate resources with schedule assumptions and offered price. Resource listing may be independent of schedule database.
    - g. Narrative explanation of project schedule development. Include impacts or resource limitations and weather conditions on project schedule development. Include planned number of work hours per day and hours per day for subcontractors.
- D. RSN 01 32 10-3, Updated Schedule Reports:
1. This submittal is required for a proper invoice for progress payments in accordance with the clauses at FAR 52.232-27 – Prompt Payment for Construction Contracts and WBR 1452.232-82 – Other Invoice Requirements.
  2. Include:
    - a. Construction Program database with updated activity and milestone data.
    - b. Definition of project calendars if revised from baseline calendars.
    - c. Primavera layout file (.plf).
    - d. Gantt chart for project on 11- by 17-inch prints and in portable document format (.pdf).
    - e. Narrative report specifically stating status of project:
      - 1) When negative float exists, cite specific actions and conditions which caused "behind schedule" condition and provide proposed course of action to complete project within specified delivery time. When float changed from previous month's updated schedule, explain reason for change.
      - 2) List of Contractor-initiated changes to current schedule stating reason for action taken and any unresolved issues relating to

Construction Program. Government reserves right to reject Contractor-initiated changes to current schedule which negatively impact any Government action which was initiated on basis of current schedule.

- 3) Discuss contract milestones and significant activities that were started, continued, or completed during update period or scheduled during next update period.

f. Submittals Register:

- 1) List submittals as listed in Table 01 33 00A – List of Submittals.
- 2) Update Submittal Register monthly to include submittals and revised submittal. Register fields shall include RSN name and number, date submitted, date of response, status (e.g. approved, partially approved, approved subject to identified changes and resubmit, or not approved).
- 3) This register document is separate from scheduling database.

E. RSN 01 32 10-4, Time Impact Analysis:

1. Include:

- a. Construction Program database with proposed revised activity and milestone data.
- b. Proposed revised schedule due to change or delay with added, changed, or deleted activities.
- c. Primavera layout file (.plf).
- d. Gantt chart for project on 11- by 17-inch print(s) and in portable document format (.pdf).
- e. Narrative report explaining results and conclusions.

## 1.05 QUALIFICATIONS

- A. Representative: Experienced in developing and maintaining construction schedules and knowledgeable of activities and progress onsite to develop and maintain accurate and reliable schedules.

## 1.06 GENERAL

- A. Develop, maintain, and use Construction Program to plan, monitor, evaluate, and report accomplishment of work.

## 1.07 SCHEDULES

- A. Prepare construction schedules using Critical Path Method, outlined in AGC Manual. Use computer software program to perform mathematical analysis of scheduling data:

1. Prepare schedule based on required sequence and interdependence of activities. Logically sequence activities.
2. Prepare detailed activity network for accomplishing required work organized by Work Breakdown Structure (WBS). Utilize WBS in lieu of activity codes for organization of schedule. If activity codes are utilized in addition to WBS, use unique activity code names assigned as project codes rather than global codes.
3. Activities except "Award" shall have predecessor activities and activities except "Contract Complete" shall have successor activities.
4. Meet contract requirements; milestone(s) in accordance with the clause at FAR 52.211-10, Commencement, Prosecution, and Completion of Work; and relevant clauses and specification sections. Include interim milestone dates, Government interface dates, contract completion date, and other time or seasonal constraints specified in contract documents.
5. Include work of subcontractors, Government interfaces, and contract milestones.
6. Adjust Construction Program/schedule for seasonal weather conditions. Provide a narrative explaining expected weather and plan for incorporation in schedule. Consider work influenced by high or low ambient temperatures or precipitation. Utilize Primavera P6 calendars to depict historical weather days that impact work. Assign weather calendars to work impacted by weather.
7. Define activities to a level of detail resulting in durations being no greater than 20-workdays:
  - a. Durations for administrative activities (e.g., submittals and reviews) fabrication, manufacturing, and typical level of effort activities (e.g. dewatering, storm water management) will not be subject to workday duration limitations.
8. Include activities for submittal preparation and submittal reviews when submittal addresses work that involves significant quantities, long lead times, is on the critical path or near critical path, or as requested by COR. Assign Government submittal review activities to a seven-day calendar with durations as specified in Section 01 33 00 – Submittals. Include required Submittal Number (RSN) in activity description.
9. Include separate activities for fabrication or manufacturing when work involves significant quantities, long lead times, is on the critical path or near critical path, or as requested by COR.
10. Include contract title, contract number, and Contractor's name on transmittal cover sheet and sheet of Gantt chart.
11. For each activity on Gantt chart, display activity identification number, activity description planned or original duration, start date, finish date, total float, and calendar identification. Do not display early start and late start fields.
12. Include table of abbreviations used in schedule, listed and defined alphabetically.

13. Use finish to start logic relationships between activities. Do not utilize start to start, finish to finish, or start to finish logic relationships. Do not use negative lead or lag times.
14. Use durations in units of whole workdays.
15. Provide best estimate of time required to complete activity considering quantity of work, work conditions, location of work, and planned resources for activity.
16. Equate durations of Government reviews and other identified actions to maximum number of calendar days specified in their respective paragraphs.
17. Establish workday calendar(s) and use these in schedule to translate activity's workday duration into calendar dates. Use calendar names unique for this project, do not use software default calendar names. Save calendars as project calendars, not global calendars.

**B. Baseline Schedule:**

1. Represents Contractor's as-planned approach to accomplishing work. Do not include actual start dates, percent completes, or actual finish dates.

**C. Updated Schedule:**

1. Meet monthly with COR at Government's project office, or at location approved by COR, to review progress made to end date of progress payment period. Establish dates that activities were started and completed and remaining duration for each activity started but not completed during period:
  - a. Discuss and mutually agree upon changes to schedule.
  - b. Out-of-sequence activities are not allowed. Revise logic to reflect change in work plan.
  - c. Finalize updated Construction Program database with mutually agreed upon changes.
2. Following receipt of executed contract modification, incorporate activity data and logic relationships stipulated in modification into current schedule for inclusion in next scheduled progress update. Provide appropriate logic relationships for revised activities.
3. Assign unique project file name for each schedule update.

**1.08 TIME IMPACT ANALYSIS**

- A. Provide time impact analysis for contract changes, (e.g., a change order, proposed modification, or value engineering change proposal) to support a claim or request for equitable adjustment to contract which involves a delay or accelerated schedule.
- B. CO may use time impact analysis to determine if a time extension or reduction to contract milestone dates are justified:

1. Time impact analysis is required for contract changes whether Contractor's current schedule milestone dates are same as, earlier than, or later than, those required under contract.
  2. Changes, additions, or deletions to activities; activity durations; or activity time frames; or activity predecessors and successors will not automatically determine that an extension or reduction of contract time is warranted or due Contractor.
  3. Time extensions for performance will be considered only to extent that Contractor's current scheduled milestone dates exceed contract milestone dates.
- C. Float is not for exclusive use by or benefit of either Government or Contractor.
- D. Perform time impact analyses using data in most recent approved schedule update prior to change or delay event:
1. Prepare proposed revised schedule and narrative description describing and highlighting changes or delays.
  2. Prepare summary comparing results of two schedule analyses: One using current schedule data from last approved updated schedule prior to event requiring analysis, and one using proposed schedule data incorporating changes or delays:
    - a. Show contract milestones and activities whose periods of performance have shifted as result of change which affects production and/or manufacture schedules, material orders, construction seasons, and labor and/or equipment utilization.
    - b. For activities directly affected by change or delay, include current and proposed items:
      - 1) Activity description.
      - 2) Types and quantities or major pieces of equipment, principal manpower, and pacing materials (materials that affect activity start, duration, or finish).
      - 3) Activity duration.
      - 4) Narrative containing rationale used in developing proposed logic relationships and activity data.
    - c. Data date for impacted schedule used in comparison shall be same as approved updated schedule data date.
    - d. Base schedule comparisons on status or work and available float at time CO directs or proposes change to work, Contractor submits a value engineering change proposal, or when a delay occurs as shown in approved updated schedule.

## **1.09 REVIEW AND EVALUATION**

- A. Baseline Schedule:
1. Within 21 calendar days after receipt of baseline schedule:

- a. CO will accept or not accept proposed baseline schedule.
  - b. Upon request from CO, meet with COR for joint review of proposed baseline schedule.
  - c. If schedule is not accepted, revise and resubmit within 7 calendar days following date of rejection letter.
- 2. Do not proceed with onsite work, except mobilization and surveying, until baseline schedule has been approved by Government.
- B. Updated Schedules:
    - 1. Government will require 14 calendar days after receipt of each monthly updated schedule to review and accept or not accept updated schedule.
    - 2. Submit updated schedule at time of submission of each invoice request for progress payment.
    - 3. If updated schedule is not accepted, revise and resubmit updated schedule within 7 calendar days following date of rejection letter.
  - C. Failure to include any element of work in schedules will not release Contractor from completing required work under contract.
  - D. Performance will be evaluated by Government using approved CPM schedules.

#### **1.10 FAILURE TO COMPLY**

- A. Failure to comply with requirements of this Section shall be grounds for a determination by CO that Contractor is not prosecuting work with sufficient diligence to ensure completion within specified time.
- B. CO may terminate Contractor's right to proceed with work, or any separable part of it, in accordance with default terms of this contract.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

Not Used

**END OF SECTION**

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**SECTION 01 33 00**  
**SUBMITTALS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. American Society of Mechanical Engineers (ASME)

1. ASME Y14.1-2005(2010)                      Decimal Inch Drawing Sheet Size and Format

B. National Institute of Building Sciences (NIBS)

1. NIBS NCS-2011                              United States National CAD Standards, Version 6

**1.03 DEFINITIONS**

A. Days: Calendar days.

B. Required Submittal Number (RSN): Identifies items to be submitted together as a complete submittal.

C. Submittal Types, as listed in Table 01 33 00A – List of Submittals:

1. A – Action:
  - a. Government will respond as to adequacy of submittal.
  - b. Action submittals are considered to be “shop drawings” within terms of the clause at FAR 52.236-21, Specifications and Drawings for Construction.
2. I – Informational:
  - a. Government will acknowledge receipt of Informational submittals.
  - b. Government may reject an Informational submittal when submittal does not comply with contract. Contractor shall correct mistakes or deficiencies in rejected Informational submittals and resubmit.
  - c. Informational submittals are considered to be “shop drawings” within terms of the clause at FAR 52.236-21, Specifications and Drawings for Construction, except that approval by Government is not required.

## 1.04 SUBMITTAL REQUIREMENTS

- A. In case of conflict between requirements of this section and requirements included elsewhere in these specifications, requirements included elsewhere take precedence.
- B. General:
  - 1. Prepare in English.
  - 2. Label with contract number, title, and RSN.
  - 3. Measurement units: US Customary Units:
    - a. Provide unique transmittal number for each submittal.
- C. Drawings:
  - 1. Minimum identification in title block:
    - a. Contract number and title.
    - b. Contractor or supplier's title and drawing number.
    - c. Date.
  - 2. Reserve 3- by 3-inch space next to title block for review stamps.
  - 3. Print Size: D size (22- by 34-inches) as defined by ASME Y14.1.
  - 4. Draw to scale using computer drafting or drafting equipment, unless otherwise specified:
    - a. Computer drafted drawings:
      - 1) In accordance with NIBS NCS.
      - 2) Electronic file format: Compatible with AutoCAD, Version 2018 or later.
      - 3) Compile using "eTransmit" utility in AutoCAD.
    - b. Drawing prepared with drafting equipment, when allowed: Lettering shall be neat.
  - 5. Drawings designated as "Government Format" in specifications:
    - a. Computer drafted.
    - b. Government will provide electronic AutoCAD format template.
    - c. Title block and sheet format:
      - 1) As shown on Drawing 40-D-7102.
      - 2) Government will provide template.
      - 3) Government will provide specific title block information to be used.

6. Final drawings:
  - a. Computer drafted.
  - b. Government will provide electronic AutoCAD format template.
  - c. Show as-built changes, including revision dates, made during installation. Indicate changes by clouding.
  - d. Electronic Files: On CD or DVD discs.
- D. Product Data:
  1. Mark manufacturer's data for commercial products or equipment, such as catalog cut sheets:
    - a. Identify manufacturer's name, type, model, size, and characteristics.
    - b. Illustrate that product or equipment meets requirements of specifications.
    - c. Mark items to be furnished in a manner that will photocopy (no highlighter).
    - d. Strike through items that do not apply.
- E. Certifications:
  1. Certifications by a registered professional: Signed and sealed by registered professional:
    - a. Not required for non-design work.
  2. Manufacturer's certifications: Signed by authorized representative of manufacturer.
- F. Manuals:
  1. Copies:
    - a. Printed copies: Bound and indexed.
    - b. Electronic copies: Searchable Adobe .pdf on CD or DVD discs:
      - 1) Bookmark longer files to assist in navigating file.
      - 2) Electronic files may be submitted as separate parts of a manual. After each separate electronic file is approved, compile each approved electronic file to assemble an entire manual which shall be consistent with final manual submittal.
  2. Contents:
    - a. Parts identification lists, lists of special tools, and accessories.
    - b. Schematics and wiring diagrams.
    - c. Detailed instructions for installing, operating, lubricating, and maintaining equipment.
    - d. As-built drawings, photographs, and test records or reports if required by specifications.

- G. Photographs:
1. Include negatives, or digital files on CD or DVD in .jpeg or similar format.

## **1.05 SUBMITTALS PROCEDURES**

- A. Submit only checked submittals. Submittals without evidence of Contractor's approval will be returned for resubmission.
- B. Submit complete sets of required materials for each RSN as specified in "Submittals Required" column in Table 01 33 00A – List of Submittals. A complete set includes all listed items for RSNs with multiple parts.
- C. Submit sets specified in "Sets to be sent:" columns in Table 01 33 00A - List of Submittals:
1. Submittals identified with "CDMS" in "Sets to be sent" column shall be submitted electronically in accordance with Section 01 31 30 – Contract Document Management System.
- D. Include the following information in transmittal letters:
1. Contract number and title.
  2. RSN for each attached submittal.
  3. Responsible code.
  4. Identify submittal as initial or resubmittal.
- E. Resubmittal of submittals not approved:
1. Mark changes such that they are readily identifiable and show revision date.
  2. Describe reasons for significant changes in transmittal letter.
  3. Resubmit returned submittals within 28-days after receiving the comments, unless otherwise directed.
  4. Requirements for initial submittals apply to resubmittals.

## **1.06 REVIEW OF SUBMITTALS**

- A. Time Required:
1. Submittal review will require 28-days for review of each submittal or resubmittal, unless otherwise specified.
  2. Time required for review of each submittal or resubmittal begins when complete sets of materials required for a particular RSN are received and extends through return mailing postmark date.

B. Time in Excess of Specified:

1. CO may extend contract completion date to allow additional time for completing work affected by excess review time:
  - a. Time extension will be to extent that excess review time caused delay to contract completion date.
  - b. Time extension will not exceed time used in excess of specified number of days for review of submittals or resubmittals.
  - c. Concurrent days of excess review time resulting from review of two or more separate submittals or resubmittals will be counted only once in extending contract completion date.
2. No time extension will be allowed if Contractor fails to make complete action submittals in sequence and within time periods specified.
3. Adjustment for delay will be made only to extent that:
  - a. Approval was required under contract, and
  - b. Requests for approval were properly and timely submitted and were approved.
4. Adjustment will be subject to terms of paragraphs (b) and (c) of the clause at FAR 52.242-14, Suspension of Work, however, no such delay shall be deemed to be a "suspension order" as the term is used in that clause.

C. Return of Submittals:

1. Return of submittals will be by CDMS response or hard copy, as applicable.
2. Action Submittals: One set of submittals required for action will be returned either approved, partially approved, approved subject to identified changes and resubmit, or not approved:
  - a. Revise and resubmit submittals not approved.
  - b. Do not change designs without approval of CO after drawings, documentation, and technical data have been approved.
  - c. Exception: Schedules will be either accepted, partially accepted or not accepted.
3. Informational Submittals: Government will acknowledge Informational submittals:
  - a. Informational submittals will not be returned when they comply with specifications.
  - b. Informational submittals that do not comply with specifications may be returned for resubmittal or additional information may be requested.

**1.07 HARD COPY OF TRANSMITTALS**

- A. Addresses for codes listed in Table 01 33 00A - List of Submittals:
1. Contracting Officer, Bureau of Reclamation, Attn: UC-840, 125 South State St., Room 6107, Salt Lake City, UT 84138-1147.
  2. Construction Engineer, Bureau of Reclamation, 1235 La Plata Hwy, Farmington, New Mexico, 87401.
  3. Technical Service Center, Bureau of Reclamation, Attn: 86-68510, PO Box 25007, Denver CO 80225-0007; Express Mail: Sixth and Kipling, Building 67, Room 152.
  4. Executive Director Gallup Joint Utilities, PO Box 1270, Gallup, New Mexico, 87305.
  5. Navajo Tribal Utility Authority (NTUA), Attn: Jim Magnuson, PO Box 1749, Shiprock, NM 87420.
- B. Send original transmittal letter with appropriate number of sets to office listed in “Responsible Code” column in Table 01 33 00A – List of Submittals:
1. Responsible codes starting with “86-6” are located in the Technical Service Center. Send these submittals to the TSC address shown above.
- C. Send copy of transmittal letter with appropriate number of sets to offices that are not the responsible code, but show “No. of sets to be sent to” in Table 01 33 00A – List of Submittals.
- D. When “No. of sets to be sent to” is 0, send a copy of transmittal letter to that office.
- E. Submittals required by the specifications, but not listed in Table 01 33 00A - List of Submittals:
1. Submit in accordance with this section.
  2. Submit to CE, unless otherwise specified.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**Table 01 33 00A – List of Submittals**

\* Submittal types: A – Action, I – Information

\*\* CO indicates Contracting Officer, CE indicates Construction Engineer, WCAO indicates Western Colorado Area Office, TSC indicates Technical Service Center Gallup indicates the City of Gallup New Mexico.

RSN	Clause or Section Title	Submittals required	Due date or delivery time	Type *	Responsible code	No. of sets to be sent to:**			
						CO	CE	TSC	Gallup/NTUA
01 14 10-1	Use of Site	Land Use and Landscape Rehabilitation Plan	At least 42-days before use of ROW	A	CE	CDMS			
01 31 19-1	Project Management and Coordination	Pre-Design Electrical Coordination Meeting Notification	Within 21-days of issuance of Notice to Proceed.	I	CE	CDMS			
01 31 19-2	Project Management and Coordination	Written Summary	Monthly once onsite construction begins.	A	CE	CDMS			
01 31 19-3	Project Management and Coordination	Off ROW Land Use Coordination	At least 28-days before use of OFF ROW land	I	CE	CDMS			
01 31 30-1	Contract Document Management System	Approval Data	Within 7-days of Award	A	CE	0	1	0	0
01 31 30-2	Contract Document Management System	Final Data	Within 14-days of completion of work	A	CE	0	2	2	0
01 32 10-1	Construction Program	Representative Information	Within 7-days after receipt of Notice of Award	I	CE	CDMS			
01 32 10-2	Construction Program	Baseline Schedule	Within 21-days after receipt of initial Notice to Proceed	A	CE	CDMS			
01 32 10-3	Construction Program	Updated Schedule Reports	Monthly or with Progress Payments	A	CE	CDMS			
01 32 10-4	Construction Program	Time Impact Analysis	Within 28-days after CO directs a contract change, with any proposal for a future modification, with any value engineering proposal, or with any request or claim for an equitable adjustment to the contract.	A	CE	CDMS			
01 35 10-1	Safety Data Sheets	Complete LHM and SDS	At least 14-days before jobsite delivery of hazardous material	I	CE	CDMS			

**Table 01 33 00A – List of Submittals**

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RSN	Clause or Section Title	Submittals required	Due date or delivery time	Type *	Responsible code	No. of sets to be sent to:**			
						CO	CE	TSC	Gallup/NTUA
01 35 10-2	Safety Data Sheets	Updated LHM and SDS	At least 14-days before jobsite delivery of hazardous material not previously listed	I	CE	CDMS			
01 35 20-1	Safety and Health (WBR 1452223-81)	Safety Program	Submitted and accepted before commencing onsite work See Section 3 of RSHS	A	CE	CDMS			
01 35 20-2	Safety and Health	Job Hazard Analysis (JHA) List	At least 30-days before beginning onsite work	A	CE	CDMS			
01 35 20-3	Safety and Health	Monthly Accident Summary Report	First day of each month. See paragraph 3.8 of RSHS	A	CE	CDMS			
01 35 20-4	Safety and Health	Documentation and Records	At least 30-days before beginning onsite work	A	CE	CDMS			
01 35 30-1	Contractor's Onsite Safety Personnel	Resume	At least 14-days before beginning onsite construction, resubmit upon personnel change	I	CE	CDMS			
01 35 30-2	Contractor's Onsite Safety Personnel	Safety Inspection Reports	At least once each week	I	CE	CDMS			
01 46 00-1	Quality Procedures	Contractor Quality Control Plan (QC)	At least 30-days before beginning onsite work	A	CE	CDMS			
01 46 00-2	Quality Procedures	Contractor's Daily Report	At the end of the following work day	I	CE	CDMS			
01 46 00-3	Quality Procedures	Quality Control Supervisor (QCS) Resume	At least 30-days before beginning onsite work	A	CE	CDMS			
01 46 00-4	Quality Procedures	Contractor's Quality Testing Plan	At least 30-days before beginning onsite work	A	CE	CDMS			
01 46 00-5	Quality Procedures	Summary of Monthly Test Results	Monthly	A	CE	CDMS			
01 46 20-1	Testing Agency Services	Testing Agencies Services Plan	At least 28-days before testing is required	A	CE	CDMS			
01 46 25-1	Special Instructions	Preconstructions Submittals	At least 28-days before start of construction activities	A	CE	CDMS			

**Table 01 33 00A – List of Submittals**

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RSN	Clause or Section Title	Submittals required	Due date or delivery time	Type *	Responsible code	No. of sets to be sent to:**			
						CO	CE	TSC	Gallup/NTUA
01 46 25-2	Special Instructions	Test Reports	Daily and 2-days for Biweekly reports	I	CE	CDMS			
01 46 25-3	Special Instructions	Certificates	At least 28-days before start of construction activities	A	CE	CDMS			
01 46 25-4	Special Instructions	Closeout Submittals	At least 28-days before start of construction activities	A	CE	CDMS			
01 51 00-1	Temporary Utilities	Water Storage	At least 42-days before beginning onsite construction	A	CE	CDMS			
01 55 00-1	Vehicular Access and Parking	Pre-Construction Digital Recording	At least 28-days before start of construction activities	A	CE	CDMS			
01 55 00-2	Vehicular Access and Parking	Post Construction and Post Repair Digital Recording	Within 28-days of completion of contract	A	CE	CDMS			
01 55 20-1	Traffic Control	Traffic Control Plan and Permit Applications	At least 70-days before affecting public traffic.	A	CE	CDMS			
01 55 20-2	Traffic Control	Permits	At least 28-days before affecting public traffic.	I	CE	CDMS			
01 56 15-1	Protection of Existing Utilities	Utility Owner Acknowledgement	At least 28-days prior to submitting pipe laying diagram	A	CE	CDMS			
01 56 15-2	Protection of Existing Utilities	Underground Utility Line Investigations	At least 28-days prior to submitting pipe laying diagram	A	CE	CDMS			
01 56 15-3	Protection of Existing Utilities	Work Plan within Utility Easements	With pipe laying diagram	A	CE	CDMS			
01 57 20-1	Environmental Controls	Copy of Applicable Air Quality Permit	At least 14-days before beginning onsite work	I	WCAO	CDMS			
01 57 30-1	Water Pollution Control	Updated Stormwater Pollution Prevention Plan (SWPPP)	At least 28-days before start of onsite construction work	A	WCAO	CDMS			
01 57 30-2	Water Pollution Control	Spill Prevention, Control, and Countermeasure (SPCC) Plan	At least 28-days before delivery or storage of oil	A	WCAO	CDMS			

**Table 01 33 00A – List of Submittals**

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RSN	Clause or Section Title	Submittals required	Due date or delivery time	Type *	Responsible code	No. of sets to be sent to:**			
						CO	CE	TSC	Gallup/NTUA
01 57 40-1	Pesticides	Pest Management/Integrated Pest Management Checklist	At least 28-days before application of first pesticide	A	CE	CDMS			
01 57 50-1	Tree and Plant Protection	Protection Plan	At least 28-days before beginning onsite work	A	CE	CDMS			
01 57 90-1	Preservation of Historical and Archeological Data	Alternate Use Area or Borrow Area	At least 28-days before beginning offsite work, if commercial days; if non-commercial site then at least 6-months prior to use of land	A	CE	CDMS			
01 71 20-1	Surveying	Surveying Plan	At least 28-days before beginning survey work	A	CE	CDMS			
01 71 20-2	Surveying	Resume	At least 28-days before beginning survey work; At least 42-days before personnel change	I	CE	CDMS			
01 71 20-3	Surveying	Accuracy Check Results	At least 28-days before beginning survey work	I	CE	CDMS			
01 71 20-4	Surveying	Completed and Reduced Survey Notes	Within 2-days of completing and reducing notes	I	CE	CDMS			
01 71 20-5	Surveying	Original Field Survey Books	Weekly	I	CE	CDMS			
01 71 20-6	Surveying	Quantity Survey Notes and Computations	Accompanying progress payment requests	I	CE	CDMS			
01 71 20-7	Surveying	Workday's Survey Notes	At conclusion of workday if requested by Government	I	CE	CDMS			
01 74 00-1	Cleaning and Waste Management	Waste Production and Disposal Plan	At least 28-days before beginning onsite work	I	CE	CDMS			
01 74 00-2	Cleaning and Waste Management	Waste Production and Disposal Records	Within 7-days of waste disposal	I	CE	CDMS			
01 74 00-3	Cleaning and Waste Management	Environmental Consultant Resume	At least 28-days before beginning environmental assessment	I	CE	CDMS			

**Table 01 33 00A – List of Submittals**

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RSN	Clause or Section Title	Submittals required	Due date or delivery time	Type *	Responsible code	No. of sets to be sent to:**			
						CO	CE	TSC	Gallup/NTUA
01 74 00-4	Cleaning and Waste Management	Environmental Site Assessment	Within 14-days of completion of work	I	CE	CDMS			
01 78 30-1	Project Record Documents	As-built and Final Drawings	Within 28-days of Government issued substantial completion of work	A	CE	0	2	0	2
01 78 30-2	Project Record Documents	Final Drawings	Within 14-days of approval of RSN 01 78 30-1	A	CE	0	2	0	2
01 78 30-3	Project Record Documents	O&M Manuals	Within 14-days of completion of project	A	CE		2	2	2
01 80 15-1	Commissioning	Qualifications	Within 150-days after Notice to Proceed, and at least 45-days prior to Commissioning	A	CE	CDMS			
01 80 15-2	Commissioning	Test Plan	60-days prior to Commissioning	A	CE	CDMS			
01 80 15-3	Commissioning	Testing Procedures	60-days prior to Commissioning	I	CE	CDMS			
01 80 15-4	Commissioning	Test Reports	Within 7-days of completing each test	I	CE	CDMS			
01 80 15-5	Commissioning	Discrepancy List	Within 7-days of completing each test	I	CE	CDMS			
01 80 15-6	Commissioning	Post Testing and Commissioning Documentation	Within 28-days of completing Commissioning	A	CE	CDMS			
03 20 00-1	Concrete Reinforcing	Reinforcement Diagrams and Lists	28-days before placing concrete	A	CE	CDMS			
03 30 00-1	Cast-In-Place Concrete	Approval Data	At least 28-days before placing concrete	A	86-68530	CDMS			
03 30 00-2	Cast-In-Place Concrete	Concrete Placement Schedule	At least 28-days before placing concrete	A	86-68530	CDMS			
03 30 00-3	Cast-In-Place Concrete	Certifications	At least 28-days before placing curing compound	A	86-68530	CDMS			

**Table 01 33 00A – List of Submittals**

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RSN	Clause or Section Title	Submittals required	Due date or delivery time	Type *	Responsible code	No. of sets to be sent to:**			
						CO	CE	TSC	Gallup/NTUA
03 30 00-4	Cast-In-Place Concrete	Test Reports	At least 28-days before placing curing compound	A	86-68530	CDMS			
03 35 10-1	Concrete Floor Hardener	Manufacturer's Instructions	At least 28-days before placing concrete	A	86-68530	CDMS			
03 48 00-1	Plant-Precast Concrete Structures	Certificates	At least 28-days before installing first structure	A	86-68120	CDMS			
03 48 00-2	Plant-Precast Concrete Structures	Shop Drawings	At least 28-days before placing concrete	A	86-68120	CDMS			
03 48 00-3	Plant-Precast Concrete Structures	Product Data and Test Reports	At least 28-days before placing concrete	A	86-68120	CDMS			
03 62 20-1	Nonshrink Grout for Equipment and Metalwork	Packaged Nonshrink Grout Data	At least 28-days before placing concrete	A	86-68530	CDMS			
03 63 00-1	Epoxy Grout	Approval Data	At least 28-days before beginning grouting	A	86-68530	CDMS			
04 22 10-1	Reinforced Concrete Unit Masonry Assemblies	Approval Data	At least 28-days before beginning construction of the wall	A	86-68120	CDMS			
04 22 10-2	Reinforced Concrete Unit Masonry Assemblies	Sample Kit	At least 28-days before beginning construction of the wall	A	86-68120	0	1	1	0
04 22 10-3	Reinforced Concrete Unit Masonry Assemblies	Certifications	At least 28-days before beginning construction of the wall	A	86-68120	CDMS			
04 22 10-4	Reinforced Concrete Unit Masonry Assemblies	Mix Design	At least 28-days before beginning construction of the wall	A	86-68530	CDMS			
04 22 10-5	Reinforced Concrete Unit Masonry Assemblies	Instructions	At least 28-days before beginning construction of the wall	A	86-68120	CDMS			
05 21 00-1	Steel Joists	Approval Drawings and Data	At least 28-days before installing framing	A	86-68120	CDMS			
05 21 00-2	Steel Joists	Welder Qualifications	At least 28-days before installing framing	A	86-68120	CDMS			

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RSN	Clause or Section Title	Submittals required	Due date or delivery time	Type *	Responsible code	No. of sets to be sent to:**			
						CO	CE	TSC	Gallup/NTUA
05 21 00-3	Steel Joists	Inspection Reports	Within 7-days after completing tests	A	86-68120	CDMS			
05 40 00-1	Cold-Formed Metal Framing	Approval Drawings and Data	At least 28-days before installing framing	A	86-68120	CDMS			
05 40 00-2	Cold-Formed Metal Framing	Certifications	At least 28-days before installing framing	A	86-68120	CDMS			
05 40 00-3	Cold-Formed Metal Framing	Erection Plans and Manual	At least 28-days before installing framing	A	86-68120	CDMS			
05 51 30-1	Aluminum Wall Ladder and Platform	Approval Drawings and Data	At least 28-days before beginning work	A	86-68120	CDMS			
05 51 30-2	Aluminum Wall Ladder and Platform	Instructions	At least 28-days before end of construction	A	86-68120	CDMS			
05 52 20-1	Fall Protection Rail System	Approval Drawings and Data	At least 28-days before beginning work on rail system	A	86-68120	CDMS			
05 52 20-2	Fall Protection Rail System	Instructions	At least 28-days before end of construction	A	86-68120	CDMS			
05 52 20-3	Fall Protection Rail System	Operation and Maintenance Manual	At least 28-days before payment	A	86-68120	CDMS			
06 82 10-1	Fiberglass Reinforced Plastic (FRP) Fabrications	Commercial Product Data	At least 28-days before beginning onsite work	I	86-68120	CDMS			
06 82 10-2	Fiberglass Reinforced Plastic (FRP) Fabrications	Approval Drawings	At least 28-days before beginning onsite work	A	86-68120	CDMS			
07 19 20-1	Silane Water Repellent	Approval Data	At least 28-days before applying repellent	A	86-68120	CDMS			
07 19 20-2	Silane Water Repellent	Instructions	At least 28-days before applying repellent	A	86-68120	CDMS			
07 19 20-3	Silane Water Repellent	Documentation	At least 28-days before applying repellent	A	86-68120	CDMS			
07 21 13-1	Sound Control Batt Insulation	Approval Data	At least 28-days before installing insulation	A	86-68120	CDMS			
07 21 13-2	Sound Control Batt Insulation	Instructions	At least 28-days before installing insulation	A	86-68120	CDMS			
07 21 20-1	Extruded Polystyrene Foam Insulation	Approval Data	At least 28-days before beginning onsite work	A	86-68120	CDMS			

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						CO	CE	TSC	Gallup/NTUA
07 21 50-1	Spray-Applied Polyurethane Foam Insulation	Approval Data	At least 28-days before installing insulation	A	86-68120	CDMS			
07 21 50-2	Spray-Applied Polyurethane Foam Insulation	Instructions	At least 28-days before installing insulation	A	86-68120	CDMS			
07 21 50-3	Spray-Applied Polyurethane Foam Insulation	Documentation	At least 28-days before installing insulation	A	86-68120	CDMS			
07 21 60-1	Insulation Jacket	Approval Data	At least 28-days before installing insulation jacket	A	86-68120	CDMS			
07 21 60-2	Insulation Jacket	Instructions	At least 28-days before installing insulation jacket	A	86-68120	CDMS			
07 41 13-1	Pre-Insulated Metal Roof Panels	Sample and Color Sample Kit	At least 28-days before installing panels	A	86-68120	0	1	1	0
						CDMS			
07 41 13-2	Pre-Insulated Metal Roof Panels	Qualifications	At least 28-days before installing panels	A	86-68120	CDMS			
07 41 13-3	Pre-Insulated Metal Roof Panels	Product Data and Shop Drawings	At least 28-days before installing panels	A	86-68120	CDMS			
07 41 13-4	Pre-Insulated Metal Roof Panels	Closeout Maintenance Data	Within 14-days of completion of onsite work	A	86-68120	CDMS			
07 42 13-1	Pre-Insulated Metal Wall Panels	Sample and Color Sample Kit	At least 42-days before installing panels	A	86-68120	0	1	1	0
						CDMS			
07 42 13-2	Pre-Insulated Metal Wall Panels	Qualifications	At least 28-days before installing panels	A	86-68120	CDMS			
07 42 13-3	Pre-Insulated Metal Wall Panels	Product Data and Shop Drawings	At least 28-days before installing panels	A	86-68120	CDMS			
07 42 13-4	Pre-Insulated Metal Wall Panels	Closeout Maintenance Data	Within 14-days of installing panels	A	86-68120	CDMS			
07 72 30-1	Roof Hatches	Sample and Color Sample Kit	At least 28-days before installing panels	A	86-68120	0	1	1	0
						CDMS			
07 72 30-2	Roof Hatches	Product Data and Shop Drawings	At least 28-days before installing panels	A	86-68120	CDMS			

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						CO	CE	TSC	Gallup/NTUA
07 92 00-1	Joint Sealants and Masonry Joints	Approval Data and Color Samples	At least 28-days before installing joint	A	86-68120	0	1	1	0
						CDMS			
07 92 00-2	Joint Sealants and Masonry Joints	Instructions	At least 28-days before installing joint	A	86-68120	CDMS			
08 11 10-1	Steel Doors and Frames	Approval Drawings and Data	At least 28-days before installing doors	A	86-68120	CDMS			
08 11 10-2	Steel Doors and Frames	Instructions	At least 28-days before installing doors	A	86-68120	CDMS			
08 33 20-1	Roll-Up Doors	Approval Drawings and Data	At least 28-days before installing doors	A	86-68120	CDMS			
08 33 20-2	Roll-Up Doors	Sample and Color Sample Kit	At least 28-days before installing doors	A	86-68120	0	1	1	0
						CDMS			
08 33 20-3	Roll-Up Doors	Certification	At least 28-days before installing doors	A	CE	CDMS			
08 33 20-4	Roll-Up Doors	Instructions	At same time as equipment is shipped	I	86-68120	CDMS			
08 51 20-1	Steel Windows	Approval Drawings and Data	At least 28-days before installing windows	A	86-68120	Ship with equipment			
08 62 00-1	Unit Skylights	Approval Drawings and Data	At least 28-days before installing skylight	A	86-68120	CDMS			
08 62 00-2	Unit Skylights	Instructions	At least 28-days before installing skylight	A	86-68120	CDMS			
08 71 00-1	Door Hardware	Hardware Schedule and Approval Data	At least 28-days before installing hardware	A	86-68120	CDMS			
08 71 00-2	Door Hardware	Instructions	At least 28-days before installing hardware	A	86-68120	CDMS			
09 29 00-1	Gypsum Board	Approval Data	At least 28-days before installing gypsum	A	86-68120	CDMS			
09 65 10-1	Rubber Wall Base	Approval Data and Color Sample Kit	At least 28-days before installing tile	A	86-68120	CDMS			
09 65 10-2	Rubber Wall Base	Instructions	At least 28-days before installing tile	A	86-68530	0	1	1	0
09 96 20-1	Coatings	Approval Data	At least 28-days before beginning coating work	A	86-68530	CDMS			
09 96 20-2	Coatings	Final Approval Data	At least 28-days before beginning coating work	A	86-68530	CDMS			
09 96 20-3	Coatings	Paint Chip Samples	At least 28-days before beginning coating work	A	86-68530	CDMS			
09 96 20-4	Coatings	Qualifications	At least 28-days before beginning coating work	A	86-68530	CDMS			

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						CO	CE	TSC	Gallup/NTUA
09 96 20-5	Coatings	Quality Control Plan	At least 28-days before beginning coating work	A	86-68530	CDMS			
09 96 20-6	Coatings	Contractor Quality Testing Report	At least 14-days after completion of test	A	86-68530	CDMS			
10 14 00-1	Signage	Shop Drawings and Approval Data	At least 28-days before beginning coating work	A	CE	CDMS			
10 14 01-1	Entry Sign	Manufacturers Information	At least 28-days before beginning coating work	A	CE	CDMS			
10 44 20-1	Fire Extinguishers	Approval Data	At least 28-days before procurement	A	86-68410	CDMS			
10 51 00-1	Lockers	Approval Data and Color Sample Kit	At least 28-days before procurement	A	86-68120	CDMS			
13 34 21-1	Metal Building System	Approval Drawings and Data	At least 28-days before procurement	A	86-68120	CDMS			
13 34 21-2	Metal Building System	Certification	At least 28-days before procurement	A	86-68120	CDMS			
13 34 21-3	Metal Building System	Design Data	At least 28-days before procurement	A	86-68120	CDMS			
13 34 21-4	Metal Building System	Erection Plans, Manual, and Documentation	At least 28-days before procurement	A	86-68120	CDMS			
21 22 00-1	Clean Agent Fire Extinguishing System	Approval Drawings and Data	At least 28-days before procurement	A	86-68410	0	1	1	0
						CDMS			
21 22 00-2	Clean Agent Fire Extinguishing System	Final Drawings and Data	Within 14-days after completing installation and testing	I	86-68410	CDMS			
21 22 00-3	Clean Agent Fire Extinguishing System	Test Reports	Within 7-days after completing tests	I	86-68410	CDMS			
22 11 10-1	Plant Auxiliary Water Systems	Approval Data and Drawings	At least 28-days before procurement	A	86-68410	CDMS			
22 11 10-2	Plant Auxiliary Water Systems	Final Drawings and Data	Within 14-days after completing installation and testing	A	86-68410	CDMS			
22 13 16-1	Plant Gravity Drainage Piping Systems	Approval Drawings and Data	At least 28-days before procurement	A	86-68410	CDMS			
22 13 16-2	Plant Gravity Drainage Piping Systems	Final Drawings and Data	Within 14-days after completing installation and testing	A	86-68410	CDMS			

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						CO	CE	TSC	Gallup/NTUA
22 14 30-1	Sump Pumping Systems	Approval Data	At least 28-days before procurement	A	86-68410	CDMS			
22 14 30-2	Sump Pumping Systems	Test Plan	At least 28-days before procurement	A	86-68410	Ship with equipment			
22 14 30-3	Sump Pumping Systems	Final Drawings and Data	Within 14-days after completing installation and testing	A	86-68410	CDMS			
22 45 00-1	Emergency Plumbing Fixtures	Approval Data and Drawings	At least 28-days before procurement	A	86-68410	CDMS			
22 45 00-2	Emergency Plumbing Fixtures	Test Plan	At least 28-days before procurement	I	86-68410	CDMS			
22 45 00-3	Emergency Plumbing Fixtures	Final Data and Drawings	At least 28-days after completion of work	A	86-68410	CDMS			
23 05 29-1	Supports for HVAC Duct	Approval Data	At least 28-days before procurement	A	86-68410	CDMS			
23 05 53-1	Identification - HVAC	Approval Data	At least 28-days before procurement	A	86-68410	CDMS			
23 05 93-1	Testing, Adjusting and Balancing for HVAC	Final Data	Within 14-days after completing installation and testing	I	86-68410	CDMS			
23 09 00-1	Instrumentation and Control for HVAC	Approval Drawings and Data	At least 28-days before procurement	A	86-68410	CDMS			
23 09 00-2	Instrumentation and Control for HVAC	Check Prints	When the equipment is shipped to the site	I	CE	CDMS			
23 09 00-3	Instrumentation and Control for HVAC	Final Drawings and Data	Within 14-days after completing installation and testing	I	86-68410	Ship with equipment			
23 33 00-1	Air Duct Accessories	Approval Data	At least 28-days before procurement	A	86-68410	CDMS			
23 33 13-1	Draft Control Damper	Approval Data	At least 28-days before installing draft control damper	A	86-68410	CDMS			
23 33 13-2	Draft Control Damper	Final Data	Within 14-days after installing draft control damper	A	86-68410	CDMS			
23 34 00-1	HVAC Fans	Approval Data	At least 28-days before procurement	A	86-68410	CDMS			

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						CO	CE	TSC	Gallup/NTUA
23 34 00-2	HVAC Fans	Final Data	Within 14-days after completing installation and testing	I	86-68410	CDMS			
23 37 00-1	Air Inlets and Outlets	Approval Data	At least 28-days before procurement	A	86-68120	CDMS			
23 37 00-2	Air Inlets and Outlets	Sample Color Kit	At least 28-days before procurement	A	86-68410	CDMS			
23 37 00-3	Air Inlets and Outlets	Final Data	Within 14-days after completing installation and testing	I	86-68410	0	1	1	0
23 81 00-1	Direct Expansion Refrigeration Air Conditioners	Approval Drawings and Data	At least 28-days before procurement	A	86-68410	CDMS			
23 81 00-2	Direct Expansion Refrigeration Air Conditioners	Check Prints	At same time as equipment is shipped to the site	I	CE	CDMS			
23 81 00-3	Direct Expansion Refrigeration Air Conditioners	Final Drawings and Data	Within 14-days after completing installation and testing	I	86-68410	Ship with equipment			
23 82 39-1	Electric Heat Units	Approval Data and Drawings	At least 28-days before procurement	A	86-68410	CDMS			
23 82 39-2	Electric Heat Units	Check Prints	At same time as equipment is shipped to the site	I	86-68410	CDMS			
23 82 39-3	Electric Heat Units	Final Data and Drawings	Within 14-days after completing installation and testing	I	86-68430	Ship with equipment			
25 00 01-1	System Control and Monitoring	Approval Data – Monitoring and Control Systems Technical Specialist Work Summary	Within 30-days after Notice to Proceed	A	86-68430	CDMS			
25 00 01-2	System Control and Monitoring	Monthly Design Coordination Meeting and Conference Call Records	Within 7-days of completion of meeting/conference call	A	86-68430	CDMS			
25 00 01-3	System Control and Monitoring	Component Data	Within 90-days after Notice to Proceed, and at least 45-days prior to installation	A	86-68430	CDMS			

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25 00 01-4	System Control and Monitoring	System Architecture	Within 90-days after Notice to Proceed, and at least 45-days prior to installation	A	86-68430	CDMS			
25 00 01-5	System Control and Monitoring	System Description Documentation	At the same time as equipment is shipped to the site	A	86-68430	CDMS			
25 00 01-6	System Control and Monitoring	Approval Drawings and Data	Within 150-days after Notice to Proceed, and at least 45-days prior to installation	A	86-68430	CDMS			
25 00 01-7	System Control and Monitoring	Approval Data – Software Development Documentation	Within 150-days after Notice to Proceed, and at least 45-days prior to installation	A	86-68430	CDMS			
25 00 01-8	System Control and Monitoring	Layout Drawings	Within 150-days after Notice to Proceed, and at least 45-days prior to installation	A	86-68430	CDMS			
25 00 01-9	System Control and Monitoring	Check Prints	At same time as equipment is shipped to the site	A	CE	CDMS			
25 00 01-10	System Control and Monitoring	Approval Data – Final Drawings, and Documentation	Within 14-days of completion of work	I	CE	CDMS			
25 00 01-11	System Control and Monitoring	Operation and Maintenance Instruction Books	Within 14-days of completion of work	I	86-68430	CDMS			
26 05 10-1	Conductors and Cables	Approval Data	Within 42-days after Pre-Design Electrical Coordination Meeting Notification	A	86-68430	CDMS			
26 05 10-2	Conductors and Cables	Construction Documentation	Within 28-days after tests are completed	I	86-68430	CDMS			
26 05 13-1	Medium-Voltage Power Cable System	Approval Drawings and Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 05 13-2	Medium-Voltage Power Cable System	Field Test Reports	Within 28-days after tests are completed	I	86-68430	CDMS			
26 05 20-1	Grounding and Bonding	Approval Drawings and Data	Within 42-days after Pre-Design Electrical Coordination Meeting	A	CE	CDMS			

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						CO	CE	TSC	Gallup/NTUA
26 05 20-2	Grounding and Bonding	As-built Drawings	Within 21-days after construction is completed	I	86-68430	CDMS			
26 05 20-3	Grounding and Bonding	Test Reports	Within 28-days after tests are completed	I	86-68430	CDMS			
26 05 33-1	Raceways and Boxes	Approval Drawings and Data	Within 42-days after Pre-Design Electrical Coordination Meeting	A	CE	CDMS			
26 05 33-2	Raceways and Boxes	As-built Drawings	Within 21-days after installation of conduit	I	86-68430	CDMS			
26 05 36-1	Cable Trays	Approval Drawings	Within 28-days after Pre-Design Electrical Coordination Meeting	A	CE	CDMS			
26 05 36-2	Cable Trays	Approval Data	Within 42-days after Pre-Design Electrical Coordination Meeting	A	CE	CDMS			
26 12 19-1	Pad Mount Transformer	Approval Drawings and Data	Within 42-days after Pre-Design Electrical Coordination Meeting	A	CE	CDMS			
26 12 19-2	Pad Mount Transformer	Factory Test Report	Within 28-days after tests are completed	I	CE	CDMS			
26 12 19-3	Pad Mount Transformer	Field Test Report	Within 28-days after tests are completed	I	CE	CDMS			
26 12 19-4	Pad Mount Transformer	Final Drawings	Within 14-days after completing installation and testing	I	CE	CDMS			
26 12 19-5	Pad Mount Transformer	Operation and Maintenance Instruction Book	Within 35-days after installation of equipment	I	CE	CDMS			
26 17 20-1	Metal-Clad Switchgear, UXA	Approval Drawings and Data	Within 70-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 17 20-2	Metal-Clad Switchgear, UXA	Approval Drawings	Within 105-days after Pre-Design Electrical Coordination Meeting	A	CE	CDMS			
26 17 20-3	Metal-Clad Switchgear, UXA	Check Prints	At same time as equipment is shipped to the site	I	86-68430	CDMS			
26 17 20-4	Metal-Clad Switchgear, UXA	Factory Test Reports	Within 28-days after tests are completed	I	86-68430	Shipped with equipment			
26 17 20-5	Metal-Clad Switchgear, UXA	Field Test Reports	Within 28-days after tests are completed	I	86-68430	CDMS			

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						CO	CE	TSC	Gallup/NTUA
26 17 20-6	Metal-Clad Switchgear, UXA	Final Drawings	Within 28-days after installation of equipment	I	86-68430	CDMS			
26 17 20-7	Metal-Clad Switchgear, UXA	Operation and Maintenance Instruction Book	Within 35-days after installation of equipment	I	86-68430	CDMS			
26 18 39-1	Medium-Voltage Motor Controllers	Approval Data	Within 70-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 18 39-2	Medium-Voltage Motor Controllers	Approval Drawings: Layouts, Nameplate List, Bill of Materials	Within 70-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 18 39-3	Medium-Voltage Motor Controllers	Approval Drawings: Schematic Diagrams	Within 84-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 18 39-4	Medium-Voltage Motor Controllers	Check Prints	At same time as equipment is shipped to the site	I	86-68430	CDMS			
26 18 39-5	Medium-Voltage Motor Controllers	Factory Test Report	Within 28-days after tests are completed	I	86-68430	Shipped with equipment			
26 18 39-6	Medium-Voltage Motor Controllers	Field Test Report	Within 28-days after tests are completed	I	86-68430	CDMS			
26 18 39-7	Medium-Voltage Motor Controllers	Final Drawings	Within 28-days after installation of equipment	I	86-68430	CDMS			
26 18 39-8	Medium-Voltage Motor Controllers	Operation and Maintenance Instruction Book	Within 35-days after installation of equipment	I	86-68430	CDMS			
26 22 12-1	Dry-Type Transformer, KCA	Approval Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 22 12-2	Dry-Type Transformer, KCA	Operation and Maintenance Instruction Book	Within 35-days after installation of equipment	I	86-68430	CDMS			
26 24 13-1	Switchboards, DCA	Approval Drawings and Data in Manufacturer's Format	Within 56-days after Notice to Proceed	A	86-68430	CDMS			

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						CO	CE	TSC	Gallup/NTUA
26 24 13-2	Switchboards, DCA	Approval Drawings in Government Format	Within 70-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 24 13-3	Switchboards, DCA	Factory Test Report	Within 14-days after tests are completed	I	CE	CDMS			
26 24 13-4	Switchboards, DCA	Check Prints	At same time as equipment is shipped to the site	I	86-68430	CDMS			
26 24 13-5	Switchboards, DCA	Final Drawings	Within 28-days after installation of equipment	I	CE	Shipped with equipment			
26 24 13-6	Switchboards, DCA	Operation and Maintenance Instruction Book	Within 35-days after installation of equipment	I	86-68430	CDMS			
26 24 41-1	Distribution Panelboards	Approval Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 24 41-2	Distribution Panelboards	Approval Layouts	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 24 41-3	Distribution Panelboards	Test Data	Within 14-days after passing test completion	I	86-68430	CDMS			
26 26 10-1	Transformer Load Center	Approval Data	At least 42-days before procurement	A	86-68410	CDMS			
26 26 10-2	Transformer Load Center	Panelboard Schedule and Circuit Directory	At least 42-days before procurement	A	86-68410	CDMS			
26 27 40-1	Wiring Devices	Approval Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68410	CDMS			
26 32 10-1	Engine-Generator Sets	Approval Drawings and Data for Engine-Generator Sets and Diesel Fuel Tanks	At least 28-days before procurement	A	86-68410	CDMS			
26 32 10-2	Engine-Generator Sets	Final Drawings and Data	Before shipment to site	I	86-68410	Shipped with equipment			
26 32 10-3	Engine-Generator Sets	Site Test Report and Photographs	Within 28-days of completing testing	I	86-68410	CDMS			
26 41 13-1	Lightning Protection for Buildings	Qualifications	At least 56-days before procurement	A	86-68410	CDMS			

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						CO	CE	TSC	Gallup/NTUA
26 41 13-2	Lightning Protection for Buildings	Approval Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68410	CDMS			
26 41 13-3	Lightning Protection for Buildings	Approval Drawings	Within 70-days after Pre-Design Electrical Coordination Meeting	A	86-68410	CDMS			
26 41 13-4	Lightning Protection for Buildings	Test Plan	At least 30-days prior to testing date	I	CO	CDMS			
26 41 13-5	Lightning Protection for Buildings	Certificate	Within 28-days of certification	A	86-68410	CDMS			
26 42 10-1	Corrosion Monitoring System	Certification and Data	At least 42-days before procuring materials	A	86-68540	CDMS			
26 42 10-2	Corrosion Monitoring System	Final Data	Within 28-days of final testing	A	86-68540	CDMS			
26 42 11-1	Submerged Galvanic Anode Cathodic Protection System	Certification and Data	At least 28-days before procuring materials	A	86-68540	CDMS			
26 42 11-2	Submerged Galvanic Anode Cathodic Protection System	Final Data	Within 28-days of final testing	A	86-68540	CDMS			
26 42 12-1	Bolted Tank Submerged Galvanic Anode Corrosion Protection System	Certification, Design and Manufacturer's Data	At least 42-days before procuring materials	A	86-68540	CDMS			
26 42 12-2	Bolted Tank Submerged Galvanic Anode Corrosion Protection System	Final Data	Within 28-days of final testing	A	86-68540	CDMS			
26 51 00-1	Interior Lighting	Approval Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			

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						CO	CE	TSC	Gallup/NTUA
26 51 00-2	Interior Lighting	As-built Drawings	Within 35-days after installation of equipment	A	86-68430	CDMS			
26 52 00-1	Emergency and Exit Lighting	Approval Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 52 00-2	Emergency and Exit Lighting	As-built Drawings	Within 35-days after installation of equipment	A	86-68430	CDMS			
26 56 00-1	Exterior Lighting	Approval Data	Within 56-days after Pre-Design Electrical Coordination Meeting	A	86-68430	CDMS			
26 56 00-2	Exterior Lighting	As-built Drawings	Within 35-days after installation of equipment	A	86-68430	CDMS			
27 30 01-1	Telephone System	Approval Drawings and Data	Within 90-days after Notice to Proceed and at least 45-days prior to installation	A	86-68430	CDMS			
27 30 01-2	Telephone System	Check Prints	At same time as equipment is shipped to the site	I	CE	CDMS			
27 30 01-3	Telephone System	Test Procedure and Test Schedule	Within 60-days prior to test	I	86-68430	CDMS			
27 20 01-4	Telephone System	Operations and Maintenance Manual	Within 14-days of completion of work	I	86-68430	CDMS			
27 30 01-5	Telephone System	Field Operational Checkout Test Report	Within 14-days of completing test	I	86-68430	0	4	1	0
28 10 01-1	Security and Surveillance Equipment	Approval Drawings and Data	Within 150-days after Notice to Proceed and at least 45-days prior to installation	A	86-68430	CDMS			
28 10 01-2	Security and Surveillance Equipment	Test Procedure and Test Schedule	Within 60-days prior to test	A	86-68430	CDMS			
28 10 01-3	Security and Surveillance Equipment	Test Report	Within 14-days of completing test	I	CE	CDMS			
28 10 01-4	Security and Surveillance Equipment	Check Prints	At same time as equipment is shipped to the site	I	CE	CDMS			

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						CO	CE	TSC	Gallup/NTUA
28 10 01-5	Security and Surveillance Equipment	Final Drawings and Operations and Maintenance Manuals	Within 14-days of completing work	I	86-68430	CDMS			
28 31 00-1	Fire Detection and Alarm	Approval Data	Within 56-days after Notice to proceed	A	CO	0	4	1	0
28 31 00-2	Fire Detection and Alarm	Test Plan and Notification	At least 30-days prior to testing date	I	CO	CDMS			
28 31 00-3	Fire Detection and Alarm	Test Reports	Within 14-days after test completion	A	86-68430	CDMS			
28 31 00-4	Fire Detection and Alarm	As-built Drawings	Within 35-days after installation of equipment	A	86-68430	CDMS			
28 31 00-5	Fire Detection and Alarm	Operations and Maintenance Instruction Book	At least 30-days prior to onsite training	A	CE	CDMS			
28 31 00-6	Fire Detection and Alarm	Training Material	At least 30-days prior to onsite training	A	CE	CDMS			
31 02 10-1	Water for Dust Abatement	Meter Calibration	At least 21-days prior to use of equipment	A	CE	CDMS			
31 02 30-1	Dust Palliative	Proposed Application Area for Dust Palliative	At least 28-days before beginning onsite work	A	CE	CDMS			
31 03 33-1	Removal of Water from Excavation	Removal of Water Plan	At least 28-days before beginning onsite work	A	CE	CDMS			
31 23 02-1	Compacting Earth Materials	Test Results	Within 7-days after completion of tests	I	CE	CDMS			
31 23 10-1	Earthwork	Processing Plan	At least 42-days before beginning onsite work	A	CE	CDMS			
31 23 10-2	Earthwork	Test Results	Within 7-days after completion of tests	I	CE	CDMS			
31 23 39-1	Disposal of Excavated Materials	Agreement and Permits	At least 28-days before beginning on site work.	A	CE	CDMS			
31 23 70-1	Controlled Low Strength Material (CLSM)	Approval Data for CLSM Produced without Native Soil	At least 28-days before beginning onsite work	A	CE	CDMS			
31 23 70-2	Controlled Low Strength Material (CLSM)	Approval Data for CLSM Produced with Native Soil	At least 28-days before beginning onsite work	A	CE	CDMS			

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						CO	CE	TSC	Gallup/NTUA
31 23 70-3	Controlled Low Strength Material (CLSM)	Quality Control Test Results	Within 7days after completion of test	I	CE	CDMS			
31 24 18-1	Gravel Drain for <del>Concrete</del> Water Storage Tanks	Laboratory Test Results	At least 28-days before beginning onsite work	A	CE	CDMS			
31 31 30-1	Soil-Applied Herbicide	Use Plan	At least 28-days before beginning onsite work	A	CE	CDMS			
31 31 30-2	Soil-Applied Herbicide	Applicator Certification	At least 28-days before beginning onsite work	A	CE	CDMS			
31 32 36-1	HDPE Geomembrane for <del>Concrete</del> Water Storage Tanks	Certification	At least 28-days before beginning onsite work	A	CE	CDMS			
31 32 36-2	HDPE Geomembrane for <del>Concrete</del> Water Storage Tanks	Pre-Construction	At least 28-days before beginning onsite work	A	CE	CDMS			
31 32 36-3	HDPE Geomembrane for <del>Concrete</del> Water Storage Tanks	Construction	At least 28-days before beginning onsite work	A	CE	CDMS			
32 12 22-1	Asphalt Concrete Pavement	Job Mix Formula (JMF)	At least 28-days before placing surfacing	A	CE	CDMS			
32 15 10-1	Gravel Surfacing	Gravel Certification	At least 14-days before placing surfacing	A	CE	CDMS			
32 15 10-2	Gravel Surfacing	Geofabric Installation	At least 14-days before placing surfacing	A	CE	CDMS			
32 15 10-3	Gravel Surfacing	Geofabric Certification	At least 14-days before placing surfacing	A	CE	CDMS			
32 17 20-1	Painted Traffic Lines and Markings	Certification	At least 14-days before placing surfacing	A	CE	CDMS			
32 17 20-2	Painted Traffic Lines and Markings	Instructions	At least 14-days before placing surfacing	A	CE	CDMS			
32 31 10-1	Chain Link Fence	Certification	At least 14-days before installing fencing	A	CE	CDMS			

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						CO	CE	TSC	Gallup/NTUA
32 31 70-1	Cattle Guards	Drawings and Data	At least 14-days before installing cattle guards	A	CE	CDMS			
32 91 60-1	Erosion Control Blanket	Manufacturer's Information	At least 14-days before placing blanket	A	CE	CDMS			
32 91 60-2	Erosion Control Blanket	Installation Plan	At least 14-days before placing blanket	A	CE	CDMS			
32 92 20-1	Seeding	Seeding Plan	At least 14-days before seeding	A	CE	CDMS			
32 92 20-2	Seeding	Certifications	At least 14-days before seeding	A	CE	CDMS			
33 09 13-1	Pressure Differential Flowmeter Systems	Approval Data	At least 14-days before procurement	A	CE	CDMS			
33 09 13-2	Pressure Differential Systems	Final Data	Before shipment to site	I	86-68410	Shipped with equipment			
33 09 13-3	Pressure Differential Flowmeter Systems	Test Reports	Within 15-days of completion of tests	I	86-68140	CDMS			
33 11 10-1	Pipeline General Requirements	Qualifications	At least 28-days before beginning onsite work	A	86-68140	CDMS			
33 11 10-2	Pipeline General Requirements	Pipelaying Diagrams	At least 28-days before manufacture of pipe and with RSN 33 11 12-1 & 33 11 17-1	A	86-68140	CDMS			
33 11 10-3	Pipeline General Requirements	Filling and Testing Plans	At least 28-days before beginning onsite work	A	86-68140	CDMS			
33 11 10-4	Pipeline General Requirements	Flotation Prevention Plan	At least 28-days before beginning onsite work	A	86-68140	CDMS			
33 11 10-4	Pipeline General Requirements	Pipe Deflection Measurements	Within 14-days of completion of backfill	A	86-68140	CDMS			
33 11 12-1	Steel Line Pipe	Shop Drawings	Submit concurrently with corresponding RSN 33 11 10-2 and at least 28-days before manufacture of pipe	A	86-68140	CDMS			
33 11 12-2	Steel Line Pipe	Ventilation Plan	At least 28-days before beginning onsite work	A	CE	CDMS			
33 11 15-1	PVC Pipe Drains <i>for Water Storage Tank</i>	Certification	At least 28-days before pipe fabrication or procurement	A	86-68140	CDMS			

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						CO	CE	TSC	Gallup/NTUA
33 11 16-1	Site Water Utility Piping	Approval Drawings	At least 28-days before pipe fabrication or procurement	A	86-68120	CDMS			
33 11 16-2	Site Water Utility Piping	Approval Data	At least 28-days before pipe fabrication or procurement	A	86-68120	CDMS			
33 11 16-3	Site Water Utility Piping	Final Drawings and Data	Within 28-days of installation of pipe	A	86-68420	CDMS			
33 11 17-1	PVC Pressure Pipe	Shop Drawings	Submit concurrently with corresponding RSN 33 11 10-2 and at least 28-days before manufacture of pipe	A	86-68140	CDMS			
33 11 17-2	PVC Pressure Pipe	Pipe Manufacture Certification	At least 28-days before procuring materials	A	86-68140	CDMS			
33 12 71-1	Vertical Pumping Units	Approval Data and Drawings	At least 56-days before procurement	A	86-68420	CDMS			
33 12 71-2	Vertical Pumping Units	Pumping Unit Calculations	At least 56 days before commencing installation	A	86-68420	CDMS			
33 12 71-3	Vertical Pumping Units	Motor Approval Data and Drawings	At least 56-days before procurement	A	86-68420	CDMS			
33 12 71-4	Vertical Pumping Units	Pump Certified Shop Test Data and Reports	Within 14 days after completing testing	A	86-68420	CDMS			
33 12 71-5	Vertical Pumping Units	Motor Factory Test Reports	Within 14 days after completing testing	A	86-68420	CDMS			
33 12 71-6	Vertical Pumping Units	Pump Final Data and Drawings	Within 14 days after completing installation	A	86-68420	CDMS			
33 12 71-7	Vertical Pumping Units	Motor Final Data and Drawings	Within 14 days after completing installation	A	86-68420	CDMS			
33 12 71-8	Vertical Pumping Units	Field Test Plan	At least 56 days before commencing field testing	A	86-68420	CDMS			
33 12 71-9	Vertical Pumping Units	Field Test Reports	Within 14 days after completing testing	A	86-68420	CDMS			
33 16 14-1	Air Chambers	Qualifications	At least 56-days before procurement	A	86-68420	CDMS			
33 16 14-2	Air Chambers	Air Chambers Data and Drawings	At least 56-days before procurement	A	86-68420	CDMS			

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						CO	CE	TSC	Gallup/NTUA
33 16 14-3	Air Chambers	Air Compressors and Compressed Air Filtration System Data and Drawings	At least 56-days before procurement	A	86-68420	CDMS			
33 16 14-4	Air Chambers	Air Compressor Piping Calculations and Drawings	At least 56-days before procurement	A	86-68420	CDMS			
33 16 14-5	Air Chambers	Commercial Products Data	At least 56-days before procurement	A	86-68420	CDMS			
33 16 14-6	Air Chambers	Service Manuals	At least 56-days before procurement	I	86-68420	CDMS			
33 16 14-7	Air Chambers	Control Cabinet Equipment Layouts, Electrical Bill of Material, Nameplate Lists, Schematic and Wiring Diagrams Approval Drawings	At least 56-days before procurement	A	86-68420	CDMS			
33 16 14-8	Air Chambers	Check Prints	At same time as equipment is shipped to the site	I	CE	Shipped with equipment			
33 16 14-9	Air Chambers	Final Drawings	Within 28-days of installation	I	CE	CDMS			
33 16 40-1	Water Storage Tanks	Designer, Erection Engineer and Contractor Qualifications	At least 56-days before construction	A	86-68420	CDMS			
33 16 40-2	Water Storage Tanks	Commercial Products Data	At least 56-days before procurement	A	86-68420	CDMS			
33 16 40-3	Water Storage Tanks	Approval Drawings	At least 56-days before construction	A	86-68420	CDMS			
33 16 40-4	Water Storage Tanks	Calculations	At least 56-days before construction	A	86-68420	CDMS			
33 16 40-5	Water Storage Tanks	Final Drawings and Data	Within 28 days of installation	I	CE	CDMS			

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						CO	CE	TSC	Gallup/NTUA
33 16 50-1	Steel Tanks	Shop Drawings, Design Calculations and Design Data Stamped and Signed by a Professional Engineer	At least 56-days before construction	A	86-68420	CDMS			
33 16 50-2	Steel Tanks	Nondestructive Weld Test Reports	Within 28-days of test completion	I	86-68120	CDMS			
33 16 51-1	Concrete Wire Wrapped Tank	Approval Drawings and Data	At least 56-days before construction	A	86-68120	CDMS			
33 16 51-2	Concrete Wire Wrapped Tank	Test Reports	Within 28-days of test completion	I	86-68120	CDMS			
33 16 51-3	Concrete Wire Wrapped Tank	Documentation	At least 56-days before construction	I	86-68120	CDMS			
33 16 51-4	Concrete Wire Wrapped Tank	Final Drawings and Data	At least 56-days before construction	I	86-68120	CDMS			
33 16 52-1	Concrete Prestressed Tank	Approval Drawings and Data	At least 56-days before construction	A	86-68120	CDMS			
33 16 52-2	Concrete Prestressed Tank	Test Reports	Within 28-days of test completion	I	86-68120	CDMS			
33 16 52-3	Concrete Prestressed Tank	Documentation	At least 56-days before construction	I	86-68120	CDMS			
33 16 52-4	Concrete Prestressed Tank	Final Drawings and Data	At least 56-days before construction	I	86-68450	CDMS			
35 21 95-1	Steel Manifold Piping	Shop Drawings	At least 42-days before manufacture of pipe	A	86-68420	CDMS			
35 21 95-2	Steel Manifold Piping	Hydraulic Thrust Analysis	At least 42-days before manufacture of pipe	A	86-68420	CDMS			
35 21 95-3	Steel Manifold Piping	Commercial Products Data	At least 42-days before construction	A	86-68420	CDMS			
35 21 95-4	Steel Manifold Piping	Pipe Installation Procedure and Calculations	At least 42-days before construction	A	86-68420	CDMS			
35 21 95-5	Steel Manifold Piping	Field Weld Test Results	Within one week after testing	A	86-68420	CDMS			
35 21 95-6	Steel Manifold Piping	Final Drawings	Within 28-days of installation	I	CE	CDMS			
35 22 14-1	Valves and Equipment	Commercial Products Data	At least 42-days before fabrication or construction	A	86-68420	CDMS			

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						CO	CE	TSC	Gallup/NTUA
35 22 14-2	Valves and Equipment	Check Prints	At same time as equipment is shipped to the site	I	CE	Shipped with equipment			
35 22 14-3	Valves and Equipment	Field Installation Procedures	At least 42-days before fabrication or procurement.	A	86-68420	CDMS			
35 22 14-4	Valves and Equipment	Shop Testing Certifications and Reports	Within 28 days after testing.	A	86-68420	CDMS			
35 22 14-5	Valves and Equipment	Service Manuals	At least 28-days before installation	I	86-68420	CDMS			
46 33 00-1	Sodium Hypochlorite Feed System	Approval Drawings and Data	At least 56-days before procurement	A	CE	CDMS			
46 33 00-2	Sodium Hypochlorite Feed System	Check Prints	At least 56-days before procurement	A	CE	CDMS			
46 33 00-3	Sodium Hypochlorite Feed System	Final Drawings and Data	No more than 28-days after installation	I	86-68410	CDMS			
46 81 53-1	Warning Signs	Approval Data	At least 56-days before procurement	A	CE	CDMS			

**END OF SECTION**

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**SECTION 01 33 26**  
**ELECTRICAL DRAWINGS AND DATA**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Electrical Drawings and Data:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American Society of Mechanical Engineers (ASME)

1. ASME Y14.1-2012                      Decimal Inch Drawing Sheet Size And Format

B. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE 315-1975(1993)                      Graphic Symbols For Electrical And Electronics Diagrams (Including Reference Designation Letters)
2. IEEE C37.2-2008                      Electrical Power System Device Function Numbers, Acronyms, and Contact Designations
3. IEEE Y32.9-1972(1989)                      Graphic Symbols for Electrical Wiring and Layout Diagrams Used in Architecture and Building Construction

C. National Electrical Manufacturers Association (NEMA)

1. NEMA ICS 1-2000(2008)                      Industrial Control and Systems: General Requirements

**1.03 SUBMITTAL PROCEDURES**

A. In addition to the requirements in Section 01 33 00 – Submittals, prepare electrical drawings and data submittals in accordance with the following.

B. Drawings, general:

1. Device designations and symbols:
  - a. Conform to IEEE 315, IEEE C37.2, IEEE Y32.9, and NEMA ICS-1.
  - b. As indicated on Standard Drawings 104-D-757 and 104-D-1150.
2. Size: D-size prints as defined in ASME Y14.1 made from original drawings.

3. Indicate changes on revised drawings to distinguish them from previous submittals. Describe reasons for significant changes in submittal letters.
- C. Approval Drawings In Government Format:
1. General:
    - a. Furnish with Government title block and in form as indicated on Standard Drawing 40-D-7102.
    - b. Government will provide specific title block information when drawings are submitted.
    - c. Government may revise conductor or device designations on Contractor's drawings when drawings are approved at no change in contract price or completion time.
  2. Schematic Diagrams:
    - a. In accordance with Standard Drawing 104-D-1150.
    - b. Format:
      - 1) Vertical ladder diagram form.
      - 2) Label rungs with sequential numbers starting with number 1.
      - 3) Locate rung numbers adjacent and to left of associated rung.
      - 4) Provide unique rung numbers for each circuit.
    - c. Conductor designations: As indicated on drawings.
    - d. Indicate device terminal designations.
    - e. Indicate functional operation.
    - f. Describe unusual or nonstandard operation.
    - g. Indicate ratings and/or values of devices.
    - h. Indicate contacts, including spare contacts, for motor contactors, auxiliary relays, timers, and protective relays.
    - i. Indicate cross-referencing between other schematic and wiring diagrams.
    - j. Do not include current and potential transformer circuits on drawing with direct-current control and protective relaying circuits.
    - k. Conductor designations: As indicated on drawings or as developed by Contractor. Contractor-developed conductor designations shall consist of:
      - 1) Circuit prefix.
      - 2) Rung number.
      - 3) Unique rung wire letter such as 5P15C ("5"-Unit Number, "P"-Protection Circuit, "15"-Rung Number, "C"-Unique Rung Wire Letter).

- l. Base instrument current and potential transformer circuit conductor designations upon primary conductor designations indicated on single-line diagram drawings.
    - m. Show switch developments for control, selector, and limit switches.
    - n. Show device and terminal block designations.
  3. Wiring Diagram Drawings:
    - a. Match with schematic diagram drawings.
    - b. Indicate point-to-point wiring in accordance with Standard Drawing 104-D-1165.
    - c. Indicate equipment as mounted on back, side, swing, and door panels. Show panel as viewed from wiring side of panel.
    - d. Identify each item of equipment with designation indicated on schematic diagram.
    - e. Identify control and protective devices with (IEEE) device number as indicated on specifications drawings or on Standard Drawing 104-D-1150.
    - f. Identify components such as fuses and resistors by value.
    - g. Indicate wiring of devices and items of equipment including terminal number.
    - h. Indicate cables, cable and individual wire designations, and connections to external circuits.
    - i. Cable designations: Similar to designations on Standard Drawing 104-D-1165.
    - j. Show no more than one panel per drawing.
  4. Sample Wiring Diagram: Sample of actual wiring diagram that will be submitted as check print and final drawing.
- D. Approval Drawings and Data in Manufacturer's Format:
  1. General: Furnish with manufacturer's standard format, except as noted below.
  2. Equipment Layout Drawings:
    - a. Indicate dimensions of equipment.
    - b. Indicate location of devices and items of equipment including nameplates, terminal blocks, wiring ducts, bus, conduit entries, and other features in their relative physical location.
    - c. Indicate method of securing equipment to deck, floor, or wall.
    - d. Identify each device and item of equipment with a bill of material reference number.

3. Bill of Material List:
  - a. Provide information on manufacturer, style, type, rating, quantity, and other identifying information for each device or item of equipment.
  - b. Provide unique reference number for each device or item of equipment listed on bill of material.
4. Nameplate Lists: Provide information on type of material, size, and engraved lettering.
5. Manufacturer's Technical Catalog Data:
  - a. Provide technical data for each device or item of equipment.
  - b. Include manufacturer's name and address; catalog number, type, style, or model number; electrical ratings; and dimensions.
  - c. Where several items are listed on same sheet, indicate items being submitted for approval.
  - d. Demonstrate proposed device or item of equipment meets specifications requirements.
  - e. Mark catalog data sheet with appropriate bill of material (BOM) item number.
  - f. Assemble catalog data sheet into one enclosing cover with bill of material (BOM) index.
6. Time-Current Characteristic and Equipment Coordination Curves:
  - a. Provide time-current characteristic curves for adjustable and non-adjustable protective devices.
  - b. Provide equipment coordination curves for:
    - 1) Transformer inrush current.
    - 2) Transformer full load current.
    - 3) Transformer thermal and mechanical damage.
    - 4) Motor inrush current.
    - 5) Motor full load current.
  - c. Original plot on log-log graph paper.
  - d. Illustrate degree of selectivity being provided.
7. Job Hazard Analysis (JHA):
  - a. Provide when the Government will be performing factory inspection.
  - b. Prepare JHA in accordance with 29 CFR 1910, Subpart I.
  - c. As a minimum include the following in JHA:
    - 1) Factory address and name of site visit contact person.

- 2) Date of JHA.
- 3) Purpose of JHA, for example “Visitor Safety Procedures”.
- 4) Hazards:
  - a) Types of hazards at factory.
  - b) Safety procedures in or around high-voltage test labs.
  - c) Safety procedures on factory floor.
- 5) Personal Protective Equipment:
  - a) List of equipment required.
  - b) List of equipment provided by factory.
- 6) Emergency response:
  - a) Name and phone number of Factory Safety Officer.
  - b) Employees trained in emergency conditions (CPR and First Aid).
  - c) Factory fire protection/evacuation procedures.
  - d) Nearest hospital or emergency room.
- 7) Name, title and signature of factory official approving JHA.

E. Check Prints:

1. Schematic and wiring diagrams which indicate “As-built” condition of equipment at time of shipment.
2. Mark as changes and revisions are made during installation and checkout of equipment.
3. Keep drawings at jobsite and mark as work progresses.
4. Maintain separate, identical set of prints for use in preparing final drawings.

F. As-built Drawings:

1. Provide for grounding, conduit, and lighting systems:
  - a. Indicate as-built changes made during construction.
  - b. Indicate dimensions of:
    - 1) Location of grounding electrodes.
    - 2) Embedded and direct buried grounding cables.
    - 3) Embedded and direct buried conduit.}}
2. Include revision dates.
3. Mark drawings in the following colors:
  - a. Red - Additions to original drawings.

- b. Green - Deletions to original drawings.
- c. Blue - Notations necessary for explanation of as-built markings.

G. Final Drawings:

- 1. Revised to reflect approval comments and as-built condition of installed equipment at time of contract completion.
- 2. Provide original plot of schematic and wiring diagrams, equipment layout drawings, bill of materials, and nameplate drawings/lists.
- 3. Provide computer drawing files on DVD disc in AutoCAD (\*.dwg).

H. Test Reports:

- 1. Typed, 8 1/2- by 11-inch sheets.
- 2. Certified.
- 3. Submit multi-page reports in bound folder or three-ring binder.

I. Operation and Maintenance Instructions Books:

- 1. Print copies:
  - a. Assemble each set of material into one or more books with enclosing covers.
- 2. Electronic copies:
  - a. Adobe Acrobat (.pdf) format on DVD discs.
  - b. Conform to print copies.
  - c. Bookmark file(s) to aid in navigating.
- 3. Provide following items:
  - a. Index sheet at front of each book which provides page or index tab number information for each device or item of equipment in book.
  - b. Manufacturer's operation and maintenance procedures; installation details, as necessary; and catalog data sheets for each device or item of equipment.
  - c. List of recommended spare parts and components.
  - d. Parts lists for replacement parts.
  - e. Manufacturer's full-size circuit breaker and fuse time-current curves.
  - f. Copies of factory test reports.
  - g. Copies of bills of materials
  - h. Copies of drawings:
    - 1) Revised to reflect approval comments.
    - 2) Maximum size: 11- by 17-inch.

**PART 2      PRODUCTS**

Not Used

**PART 3      EXECUTION**

Not Used

**END OF SECTION**

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**SECTION 01 35 10**  
**SAFETY DATA SHEETS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 DEFINITIONS**

A. LHM: List of Hazardous Materials.

B. SDS: Safety Data Sheet.

1. Referred to as Material Safety Data Sheets in the clause at 52.223-3, Hazardous Material Identifications and Material Safety Data - Alternate 1.

**1.03 APPLICATION**

A. For the purposes of this contract, “delivered under this contract” in paragraph (b) of the clause at FAR 52.223-3, Hazardous Material Identification and Material Safety Data - Alternate 1, includes materials:

1. Delivered to Government.
2. Incorporated into work.
3. Materials used by Contractor during contract performance at jobsite.

**1.04 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 - Submittals.

B. RSN 01 35 10-1, Complete LHM and SDS.

C. RSN 01 35 10-2, Updated LHM and SDS.

1. Comply with paragraph (e) of clause at FAR 52.223-3, Hazardous Material Identification and Material Safety Data - Alternate 1.

**1.05 DELIVERY**

A. Do not deliver hazardous materials to jobsite which are not included on original or previously updated LHM and SDS before receipt of updated LHM and SDS by CE.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 35 20**  
**SAFETY AND HEALTH**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. Bureau of Reclamation (USBR)

1. RSHS Reclamation Safety and Health Standards including revisions posted at:  
<http://www.usbr.gov/ssle/safety/RSHS/rshs.html>
2. FIST 1-1 (2012) Hazardous Energy Control Program available at: [www.usbr.gov/power/data/fist\\_pub.html](http://www.usbr.gov/power/data/fist_pub.html)

B. Applicable Tribal and State Safety and Health Regulations for Construction.

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN I-1, Safety Program:

1. Written safety program in accordance with of RSHS.
2. Cover aspects of onsite and applicable off site operations and activities associated with this contract.
3. Follow outline in Appendix B of RSHS
4. Will not be accepted for review by COR unless it addresses, in order, lettered and numbered per Appendix B, a narrative for each applicable item in the outline. For items in the outline that do not apply to this contract write “Not applicable to Contract” next to number/letter.
5. Generic company safety program is not acceptable. Safety Program must be site specific for this contract.
6. Submitted and accepted prior to commencing onsite work, including mobilization.

- C. RSN 01 35 20-2, Job Hazard Analysis List:
  - 1. Provide list of JHA's that shall be submitted throughout project.
- D. RSN 01 35 20-3, Monthly Accident Summary Report:
  - 1. In accordance with RSHS.
- E. RSN 01 35 20-4 Documentation and Records
  - 1. Submit documentation of medical qualifications less than 12-months old for all respirator users at site.
  - 2. Submit results of fit tests less than 12-months old for all users of tight fitting negative pressure respirators at site.

#### **1.04 DOCUMENTATION AND RECORDS**

- A. Prepare and retain all safety plans, programs, training content, and training records that are applicable to scope of work and make them available to COR unless they are already included in the written safety program. Some examples include but are not limited to:
  - 1. Confined Space and when deemed necessary by existing and/or introduced hazards of Permit Required Confined Space through the Written Program and Training Records.
  - 2. Forklifts and Other Industrial Trucks Training Records.
  - 3. Electrical Safety Requirement Training Records.
  - 4. Emergency Action Plans Written Program and Training Records.
  - 5. Fall Protection Written Program and Training Records.
  - 6. Fire Protection and Prevention Written Program and Training Records.
  - 7. Flammable and Combustible Liquids Written Spill Control Plan.
  - 8. General Safety and Health Provisions, Written Safety Program, and Regular Safety Inspection Records.
  - 9. Hazard Communication Written Program and Training Records.
  - 10. Ladder Written Compliance Program and Training Records.
  - 11. Lockout/Tagout: Refer to RSHS Section 15 Hazardous Energy Control Program (HECP) Training Records.
  - 12. Occupational Noise Exposure Written Program and Training Audiometric Testing Records.
  - 13. Personal Protective Equipment (PPE) Hazard Assessments and Training Records.
  - 14. Power Operated Hand Tools Training Records.
  - 15. Respiratory Protection Written Program and Training Records.
  - 16. Safety Training and Education Written Program and Training Records.

17. Steel Erection Training Records, if applicable.
18. Welding, Cutting, and Brazing Written Program and Training Records.]

## **1.05 SAFETY AND HEALTH**

- A. Provide and maintain work environment and procedures that:
  1. Safeguard public, Government personnel, and Contractor employees exposed to Contractor operations and activities.
  2. Avoid interruptions of site operations and delays in project completion dates.
  3. Control costs in contract performance.
- B. Do not begin onsite work, including mobilization, until COR accepts Safety Program.
- C. Participate in Contractor Safety Program Review meeting prior to mobilization.
- D. Minimum work crew shall consist of no less than two (2) people, unless approved by COR.
- E. Develop Job Hazard Analyses (JHAs) for each distinct phase of work under the contract:
  1. Do not begin a phase of work until JHA is acceptable to COR and shared with construction employees.
  2. Activities involving hazardous materials shall have appropriate Safety Data Sheet(s) attached to JHA.
- F. Comply with RSHS 29 CFR 1926 "Accident Prevention and WAC":
  1. Construction Safety and Health Standards promulgated by the Secretary of Labor may be obtained from any regional or area office of the Occupational Safety and Health Administration of the U.S. Department of Labor.
- G. Correct safety and health violations identified by CO or COR.
- H. When Contractor fails or refuses to correct a compliance directive, CO may issue an order to stop all or part of the work:
  1. When satisfactory corrective action is taken, an order to resume work will be issued.
  2. Contractor shall not be entitled to extension of time, to claim for damage or additional compensation by reason of either directive or stop order.
  3. Failure of CO to order discontinuance of Contractor's operations shall not relieve Contractor of responsibility for safety of personnel and property.
- I. Maintain accurate records of and report to CO the following occurrences during performance of this contract:
  1. Death.

2. Occupational disease.
  3. Traumatic injury to employees or public.
  4. Property damage in excess of \$2,500.
- J. Provide appropriate safety barricades, signs, and warnings.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 35 30**  
**CONTRACTOR'S ONSITE SAFETY PERSONNEL**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 01 35 30-1, Resume:

1. Contractor's Onsite Safety Professional.

C. RSN 01 35 30-2, Safety Inspection Reports:

1. List noted deficiencies, their abatement dates, and follow-up action for jobsite activities.
2. Base inspection report on findings of jobsite walk-through with Government personnel.

**1.03 QUALIFICATIONS**

A. Contractor's Onsite Safety Representative:

1. Competent supervisory employee with appropriate level of safety related training and experience prior to start of the work.

**1.04 APPLICATION**

A. Designate an employee as Contractor's Onsite Safety Representative prior to start of construction:

1. Safety Professional requirements may be met by retaining appropriate level of services of an acceptable safety consultant.

B. Contractor's Onsite Safety Representative Authorities, Duties, and Responsibilities:

1. Responsible for effectively implementing Contractor's Safety Program.
2. Full authorization to correct unsafe acts on the spot.
3. Prepare safety inspection reports.
4. Onsite during construction activities.

**1.05 QUALITY ASSURANCE**

A. Contractor's Onsite Safety Representative:

1. Effectiveness of Contractor's Onsite Safety Representative in prosecuting the safety program will be subject to continued review and approval by CO.
2. Should Contractor's safety effort be considered inadequate, CO has option to require Contractor to employ a full-time qualified Safety Professional.

B. Safety Program:

1. Effectiveness of Contractor's Safety Program will be subject to continued review and approval by CO.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 42 10**  
**REFERENCE STANDARDS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

- A. Referenced editions of standard specifications, codes, and manuals form a part of this specification to extent referenced.
- B. These specifications take precedence when conflicting requirements occur between specifications and referenced standard.

**1.03 JOBSITE REFERENCE STANDARDS**

- A. Maintain at fabrication site, access to referenced standard specifications, codes, and manuals required for work in progress at fabrication site. Make available for use by Government.
- B. Maintain onsite, access to referenced standard specifications, codes, and manuals required for onsite work in progress. Make available for use by Government.

**1.04 AVAILABILITY**

A. Code of Federal Regulation (CFR):

1. Available online, authorized by the National Archives and Records Administration (NARA) and the Government Printing Office (GPO), at [www.gpoaccess.gov/cfr/index.html](http://www.gpoaccess.gov/cfr/index.html).

B. Federal Specifications, Standards, and Commercial Item Descriptions; and Military Specifications:

1. Copies of Federal Specifications, Standards, and Commercial Item Descriptions may be obtained from GSA Federal Supply Service, see the provision at FAR 52.211-1, Availability of Specifications Listed in the GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, FPMR Part 101-29.
2. Copies of Military Specifications may be obtained from Department of Defense, see the provision at FAR 52.211-2, Availability of Specifications, Standards, and Data Item Descriptions Listed in the Acquisition Streamlining and Standardization Information System (ASSIST).

## C. Bureau of Reclamation Documents:

1. Reclamation Safety and Health Standards (RSHS), 2009 edition with revisions, may be downloaded at <http://www.usbr.gov/ssle/safety/RSHS/rshs.html>.
  - a. Hard copies of RSHS, stock number 024-003-00204-6, may be purchased from The Superintendent of Documents at the U.S. Government Printing Office (GPO), phone number (202) 512-1800. Hard copies of RSHS are subject to revisions posted on the site shown above.
    - 1) GPO online  
bookstore:<http://bookstore.gpo.gov/actions/GetPublication.do?stocknumber=024-003-00204-6>.
2. Bureau of Reclamation Standard Specifications are designated with an M-number. Copies of individual standards may be obtained from Bureau of Reclamation, Attn: 86-68510, PO Box 25007, Denver CO 80225-0007. Specify standard(s) needed when requesting a copy.
3. Bureau of Reclamation manuals and other publications including significant scientific, technical, and engineering works are available from the National Technical Information Service (NTIS). Information regarding availability and pricing may be obtained by contacting NTIS at the following address:

United States Department of Commerce  
National Technical Information Service  
5285 Port Royal Road  
Springfield, Virginia 22161  
Telephone: (703)487-4650 or 1-800-553-6847

## D. Industrial and Governmental Documents:

1. When a reference has a joint designation (e.g. ANSI/IEEE) these specifications generally cite the proponent organization (e.g. IEEE).
2. Addresses for obtaining industrial and governmental (other than Federal and Bureau of Reclamation specifications and standards) specifications, standards, and codes are listed in Table 01 42 10A - Addresses for Specifications, Standards, and Codes.

Table 01 42 10A - Addresses for Specifications, Standards, and Codes

Acronym	Name and Address	Telephone
AA	Aluminum Association 1400 Crystal Drive Suite 430 Arlington, VA 22202 <a href="http://www.aluminum.org">www.aluminum.org</a>	703-358-2960

Table 01 42 10A - Addresses for Specifications, Standards, and Codes

Acronym	Name and Address	Telephone
AABC	Associated Air Balance Council 1518 K Street NW, Suite 503 Washington, DC 20005 <a href="http://www.aabc.com">www.aabc.com</a>	202-737-0202
AAMA	American Architectural Manufacturers Association 1827 Walden Office Square, Suite 550 Schaumburg, Illinois 60173-4268 <a href="http://www.aamanet.org">www.aamanet.org</a>	847-303-5664
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, NW., Suite 249 Washington, DC 20001 <a href="http://www.aashto.org">www.aashto.org</a>	202-624-5800 800-231-3475
ABMA	American Bearing Manufacturers Association 2025 M. Street, NW, Suite 800 Washington D.C. 20036-3309 <a href="http://www.americanbearings.org">www.americanbearings.org</a>	202-367-1155
ACI	American Concrete Institute 38800 Country Club Dr. Farmington Hills, MI 48331-3439 USA <a href="http://www.concrete.org">www.concrete.org</a>	248-848-3700
AGC	Associated General Contractors of America 333 John Carlyle Street, Suite 200 Alexandria, VA 22314 <a href="http://www.agc.org">www.agc.org</a>	703-548-3118
AISC	American Institute of Steel Construction One East Wacker Drive, Suite 3100 Chicago, IL 60601-2001 <a href="http://www.aisc.org">www.aisc.org</a>	312-670-2400
AISI	American Iron and Steel Institute 25 Massachusetts Ave., NW, Suite 800 Washington, DC 20001 <a href="http://www.steel.org">www.steel.org</a>	202-452-7100

Table 01 42 10A - Addresses for Specifications, Standards, and Codes

Acronym	Name and Address	Telephone
AMCA	Air Movement and Control Association International, Inc. AMCA International 30 W. University Dr. Arlington Heights, IL 60004 <a href="http://www.amca.org">www.amca.org</a>	847-394-0150
ANSI	American National Standards Institute 1819 L. Street, NW. Washington, DC 20036 <a href="http://www.ansi.org">www.ansi.org</a>	202-293-8020
APA/EWA	APA-The Engineered Wood Association P.O. Box 11700 Tacoma, WA 98411-0700 <a href="http://www.apawood.org">www.apawood.org</a>	253-565-6600
ASME	American Society of Mechanical Engineers 3 Park Avenue New York, NY 10016-5990 <a href="http://www.asme.org">www.asme.org</a>	800-843-2763
ASTM	ASTM International P.O. Box C700 100 Barr Harbor Drive West Conshohocken, PA 19428-2959 <a href="http://www.astm.org">www.astm.org</a>	610-832-9585
AWWA	American Water Works Association 6666 W. Quincy Ave. Denver, CO 80235 <a href="http://www.awwa.org">www.awwa.org</a>	303-794-7711
AWS	American Welding Society 550 NW LeJeune Road Miami, FL 33126 <a href="http://www.amweld.org">www.amweld.org</a>	800-443-9353 305-443-9353
BHMA	Builders Hardware Manufacturers Association 355 Lexington Avenue, 17 <sup>th</sup> Floor New York, NY 10017 <a href="http://www.buildershardware.com">www.buildershardware.com</a>	212-297-2122 Fax 212-320-9047

Table 01 42 10A - Addresses for Specifications, Standards, and Codes

Acronym	Name and Address	Telephone
BICSI	Building Industry Consulting Services International 8610 Hidden River Pkwy Tampa, Florida <a href="http://www.bicsi.org">www.bicsi.org</a>	800-242-7405
CISPI	Cast Iron Soil Pipe Institute 2401 Fieldcrest Dr. Mundelein, IL 60060 <a href="http://www.cispi.org">www.cispi.org</a>	224-864-2910
CLFMI	Chain Link Fence Manufacturers Institute 10015 Old Columbia Rd. Suite B215 Columbia, MD 21046 <a href="http://www.chainlinkinfo.org">www.chainlinkinfo.org</a>	301-596-2583
DIN	Deutsches Institut für Normung E.V. German Institute of Standards Saatwinkler Damm 42/43 13627 Berlin <a href="https://www.din.de/en">https://www.din.de/en</a>	+49 30 201 1331
HI	Hydraulic Institute 6 Campus Drive, First Floor North Parsippany, NJ 08807 <a href="http://www.pumps.org">www.pumps.org</a>	973-267-9700
ICC	International Code Council 500 New Jersey Avenue, NW 6th Floor, Washington, DC 20001 <a href="http://www.iccsafe.org">www.iccsafe.org</a>	888-422-7233
ICEA	Insulated Cable Engineers Association P.O. Box 1568 Carrolton, GA 80112 <a href="http://www.icea.net">http://www.icea.net</a>	
ICRI	International Concrete Repair Institute 3166 S. River Road, Suite 132 Des Plaines, IL 60018 <a href="http://www.icri.org">www.icri.org</a>	847-827-0830 Fax 847-827-0832

Table 01 42 10A - Addresses for Specifications, Standards, and Codes

Acronym	Name and Address	Telephone
IEC	International Electrical Commission IEC Regional Centre for North America (IEC-ReCNA) 1740 Massachusetts Avenue, Suite D Boxborough, MA 01719. <a href="http://www.iec.ch">www.iec.ch</a>	978-266 0414 Fax 978-266 0415
IEEE	Institute of Electrical and Electronics Engineers 3 Park Avenue, 17th Floor New York, NY 10016-5997 <a href="http://www.ieee.org">www.ieee.org</a>	212-419-7900
ISO	International Organization for Standardization 1, ch. de la Voie-Creuse, Case postale 56 CH-1211 Geneva 20, Switzerland <a href="http://www.iso.org">www.iso.org</a>	+41 22 749 01 11
MBMA	Metal Building Manufacturers Association 1300 Sumner Avenue Cleveland, OH 44115-2851 <a href="http://www.mbma.com">www.mbma.com</a>	216-241-7333
MIC	Masonry Industry Council Mason Contractors Association of America 1910 South Highland Avenue, Suite 101 Lombard, IL 60148 <a href="http://www.masonryinstitute.org">www.masonryinstitute.org</a>	630-705-4200
MPI	Master Painters Institute 2800 Ingleton Ave. Burnaby, B.C. Canada V5C 6G7 <a href="http://www.paintinfo.com">www.paintinfo.com</a>	604-298-7578
MSS	Manufacturers Standardization Society 127 Park St. NE Vienna, VA, 22180-4602 <a href="http://www.msshq.org">www.msshq.org</a>	703-281-6613
NACE	NACE International 1440 South Creek Drive Houston, TX 77084 <a href="http://www.nace.org">www.nace.org</a>	281-228-6200

Table 01 42 10A - Addresses for Specifications, Standards, and Codes

Acronym	Name and Address	Telephone
NAPF	National Association of Pipe Fabricators, Inc. 1901 N.W. 161 <sup>st</sup> Street Edmond, OK 73013 <a href="http://www.napf.com">www.napf.com</a>	888-798-1924 Fax 800-860-5700
NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877 <a href="http://www.nebb.org">www.nebb.org</a>	301-977-3695
NECA / NEIS	National Electrical Installation Standards 3 Bethesda Metro Center, Suite 1100 Bethesda, MD 20814 <a href="http://www.neca-neig.org">www.neca-neig.org</a>	301-657-3110
NEMA	National Electrical Manufacturers Association 1300 N 17th Street, Suite 1847 Rosslyn, VA 22209 <a href="http://www.nema.org">www.nema.org</a>	703-841-3200
NETA	International Electrical Testing Association 3050 Old Centre Ave., Suite 102 Portage, MI 49024 <a href="http://www.netaworld.org">www.netaworld.org</a>	269-488-6382
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101 <a href="http://www.nfpa.org">www.nfpa.org</a>	800-344-3555 617-770-3000
NIBS	National Institute of Building Sciences 1090 Vermont Avenue, NW., Suite 700 Washington, DC 20005-4905 <a href="http://www.nibs.org">www.nibs.org</a>	202-289-7800
NSF	National Sanitation Foundation 789 N. Dixboro Road Ann Arbor, MI 48105 <a href="http://www.nsf.org">www.nsf.org</a>	734 769 8010
NNOSHA	Navajo Nation Occupational Safety and Health Administration <a href="http://www.nnosha.org">www.nnosha.org</a>	928-871-6742

Table 01 42 10A - Addresses for Specifications, Standards, and Codes

Acronym	Name and Address	Telephone
SAE	Society of Automotive Engineers International SAE World Headquarters 400 Commonwealth Drive Warrendale, PA 15096-0001 <a href="http://www.sae.org">www.sae.org</a>	724-776-04841 Fax 724-776-0790
SDI	Steel Deck Institute P.O. Box 25 Fox River Grove, IL 60021 <a href="http://www.sdi.org">www.sdi.org</a>	(847) 462-1930
SDI	Steel Door Institute 30200 Detroit Rd. Cleveland, OH 44145-1967 <a href="http://www.steeldoor.org">www.steeldoor.org</a>	(440) 899-0010
SJI	Steel Joist Institute 3127 10th Ave., North Ext. Myrtle Beach, SC 29577-6760 <a href="http://www.steeljoist.org">www.steeljoist.org</a>	(843) 626-1995
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association 4201 Lafayette Center Dr. Chantilly, VA 20151-1209 <a href="http://www.smacna.org">www.smacna.org</a>	(703) 803-2980
SSPC	SSPC: The Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222-4656 <a href="http://www.sspc.org">www.sspc.org</a>	800-837-8303 412-281-2331
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance	TIA/EIA
UL	Underwriters Laboratories, Inc. 333 Pfingsten Road Northbrook, IL 60062-2096 <a href="http://www.ul.com">www.ul.com</a>	847-272-8800

**PART 2 PRODUCTS**

Not Used

**PART 3      EXECUTION**

Not Used

**END OF SECTION**

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**SECTION 01 46 00**  
**QUALITY PROCEDURES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 DEFINITIONS**

A. Quality Assurance: Inspection and tests performed by Government to ensure compliance with terms of contract.

B. Quality Control: Activities performed by Contractor to ensure work conforms to contract requirements:

1. The clause at FAR 52.246-12 - Inspection of Construction, requires Contractor to establish an inspection system to ensure quality.
2. Quality Control includes activities in addition to specified Contractor Quality Testing to ensure work conforms to contract requirements.

C. Contractor Quality Testing: Specified tests shall be performed by Contractor:

1. Government may use test results for Quality Assurance.
2. Contractor may use test results as part of Contractor's Quality Control:
  - a. Government anticipates that these tests will be part of Contractor's Quality Control Program, however the tests do not relieve Contractor of providing adequate quality control measures in accordance with the clause at FAR 52.246-12 - Inspection of Construction.

D. Definable Features of Work: A definable feature of work is a task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or may be work by the same trade in a different environment.

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 01 46 00-1, Contractor Quality Control Plan (QC):

1. Content of the Quality Control (QC) Plan shall clearly outline Contractors Quality Control Program. This plan shall include, as a minimum, the following to cover

all construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:

- a. Description of the quality control organization, including a chart showing lines of authority and acknowledgement that Quality Control Supervisor (QCS) staff shall implement the three phase control system for all aspects of work specified.
- b. Staff shall include a Quality Control Supervisor (QCS) who shall report to project superintendent:
  - 1) An alternate QCS with equal lines of authority to act on behalf of the primary QCS should they not be present on the project site.
  - 2) Names, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
- c. Letter to the QCS, signed by an authorized official of the firm, which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the QCS:
  - 1) Including authority to stop work which is not in compliance with the contract.
- d. QCS shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities:
  - 1) Letters shall also be furnished to Government.
- e. Procedures for:
  - 1) Scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
  - 2) Control, verification, and acceptance testing procedures for each specific test to include:
    - a) Test name.
    - b) Specification paragraph requiring test.
    - c) Feature of work to be tested.
    - d) Test frequency.
    - e) Person responsible for each test.
  - 3) Tracking:
    - a) Preparatory.
    - b) Initial
    - c) Follow-up control phases and control.
    - d) Verification and acceptance tests including documentation.

- e) Construction deficiencies from identification through acceptable corrective action:
    - i. Procedures shall establish verification that identified deficiencies have been corrected.
  - 4) Reporting procedures, including proposed reporting formats.
  - f. A list of Definable Features of Work. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable features under a particular section:
    - 1) List will be agreed upon during a coordination meeting prior to start of construction.
2. Program shall be based upon definable features of work and include three phases for each feature:
- a. Preparatory Phase:
    - 1) Performed prior to beginning of work and as detailed below:
      - a) Review of each paragraph of applicable specifications and references.
      - b) Review of contract plans or shop drawings.
      - c) Check to assure that all materials and/or equipment have been tested, submitted, and approved.
      - d) Check to assure that provisions have been made to provide required control inspection and testing.
      - e) Examination of work area to assure all required preliminary work has been completed.
      - f) Physical examination of required materials, equipment, and sample work to assure:
        - i. Materials are on hand and conform to approved shop drawings or submitted data
        - ii. Have been properly stored.
      - g) Review of appropriate job hazard analyses.
      - h) Discussion of procedures for constructing work, including review of repetitive deficiencies.
      - i) Notify COR 48-hours prior to beginning any required action of preparatory phase as required in quality control specifications.
      - j) Arrange quality control testing if required.

- 2) Preparatory Meeting: Conducted by QCS, and attended by the superintendent, other quality control personnel, foreman responsible for definable feature, and Government:
  - a) Results of preparatory phase actions shall be discussed in Preparatory Meeting and be documented by separate minutes prepared by QCS and attached to daily Contractor's Quality Control Report.
- b. Initial Phase:
  - 1) Accomplished at beginning of a definable feature of work.
  - 2) Verify that control for feature of work developed in Preparatory Meeting is implemented and feature of work is performed to the level of workmanship required.
  - 3) Perform as detailed below:
    - a) Review minutes of Preparatory Meeting.
    - b) Check preliminary work.
    - c) Verify adequacy of controls to ensure full contract compliance.
    - d) Establish levels of workmanship.
    - e) Resolve all differences.
    - f) Check safety to include compliance with safety plan and Job Hazard Analysis (JHA):
      - i. Review JHA with workers.
    - g) Notify COR 48-hours in advance of beginning any required action of initial phase as required in quality control specifications.
  - 4) Include an Initial Phase Meeting conducted by QCS and attended by superintendent, other quality control personnel, foreman responsible for definable feature and Government:
    - a) Results of initial phase actions shall be discussed in Initial Phase Meeting, be documented by separate minutes prepared by QCS and attached to daily Contractor's Quality Control Report.
- c. Follow-Up Phase:
  - 1) Perform daily checks to assure continuing compliance with contract requirements, including safety and control testing until completion of particular feature of work.
  - 2) Make checks a matter of record in Contractor's Quality Control documentation.

- 3) Conduct final follow-up checks and confirm all deficiencies are corrected prior to start of additional features of work.
- 4) Quality control personnel shall continually refer to standards set in Preparatory Meeting and Initial Phases.

C. RSN 01 46 00-2, Contractor's Daily Report:

1. Submit daily reports no later than the end of the following work day.
2. As a minimum, Contractor's Daily Report shall include the following:
  - a. Record of all Contractor's activities throughout shift regardless of how minor or complex.
  - b. Report shall be started at beginning of shift, written during shift, and completed at the end of shift.
  - c. Finished report shall be prepared in such detail that a person not familiar with the day's work could determine what was done and calculate Contractor's direct cost for that day.
  - d. Report shall state specific safety violations noted during shift including action(s) taken, including:
    - 1) Names of people involved in infraction
    - 2) Name of person confirming correction.
    - 3) Document significant discussions held between Reclamation and Contractor personnel or other parties involved with project.
  - e. Main body of report shall contain:
    - 1) Locations and a detailed description of all work, including:
      - a) Sketches or photographs where appropriate to assist in description.
      - b) Description shall reflect what, where, when, why, who, and how work was being performed.
      - c) Provide:
        - i. Record of quantities installed.
        - ii. Specific stations or location of work.
        - iii. Description by CPM program activity (if applicable).
        - iv. Show labor classification, work labor force and equipment actually used during shift.
3. Report shall also contain:
  - a. List of materials and equipment delivered to job site:
    - 1) Materials installed during shift.

- 2) Materials refused or wasted during shift.
- 3) Other items to be reported include:
  - a) Changes in site conditions.
  - b) Modifications in design and installation.
  - c) Photographs taken.
  - d) Environmental compliance or noncompliance.
  - e) Hazardous waste and material concerns.
  - f) Landowner contacts.
  - g) Worker complaints.
  - h) Potential problems observed.

D. RSN 01 46 00-3, Quality Control Supervisor (QCS) Resume:

1. Designation of authorized individual as QCS to develop and manage quality control processes.
2. Designated QCS Resume.

E. RSN 01 46 00-4, Contractor's Quality Testing Plan:

1. Address methods, procedures, frequencies, and scheduling for performing quality testing as required in other specification sections.

F. RSN 01 46 00-5, Summary of Monthly Test Results.

#### **1.04 QUALIFICATIONS**

A. Contractor shall designate employee as Quality Control Supervisor (QCS).

B. Quality Control Supervisor (QCS):

1. Experienced QCS must be a graduate engineer, graduate architect, or graduate of construction management, with a minimum of 4 years' construction experience in charge of quality control for projects similar in nature to that required by this contract, or a construction person with 10 years in related QC work.
2. Both QCS and alternate will have the authority to stop work if necessary.
3. QCS shall hold no other duties.

#### **1.05 TESTING ACCEPTANCE**

A. Acceptance of material shall be based on passing of both quality control testing and quality assurance testing.

B. Government quality assurance testing results will prevail in the event of a discrepancy between Contractor's test results and Government test results.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION****3.01 QUALITY ASSURANCE**

- A. During course of work, Government may perform quality assurance tests. Tests performed by Government will be used to ensure compliance with contract requirements and not as a replacement for specified Contractor quality testing:
1. Upon request, make measuring and testing devices available for use by Government for verification tests.
- B. Contractor's QCS:
1. Effectiveness of the QCS in prosecuting QC Program will be subject to continued review and approval by CO.
  2. Should QCS's efforts be deemed insufficient Contractor may be required to replace QCS at no additional cost to Government.
- C. Contractor's Quality Control (QC) Program:
1. Effectiveness of Contractor's QC Program will be subject to continued review and approval by CO.

**END OF SECTION**

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**SECTION 01 46 20**  
**TESTING AGENCY SERVICES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for items of work requiring applicable testing agency services.
- B. Progress Payments: If test reports are not submitted in a timely manner, Contractor will be considered to be in non-compliance and delaying that phase of the work to which the testing applies. CO may retain appropriate amounts of applicable progress payments.

**1.02 REFERENCE STANDARDS**

- A. ASTM International (ASTM)
1. ASTM C1077-14 Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
  2. ASTM D666-13 Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
  3. ASTM D3740-12a Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
  4. ASTM E329-14a Agencies Engaged in Construction Inspection, Testing, or Special Inspection
  5. ASTM E543-15 Agencies Performing Nondestructive Testing

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 46 20-1, Testing Agency Services Plan:
1. Names of agencies to perform sampling and testing.
  2. Agency accreditation to perform specified testing or agency qualifications to perform specified testing.
  3. Resumes of personnel performing tests.

4. Samples of report forms.
5. No change in the approved plan may be made without written concurrence by COR.

#### **1.04 QUALIFICATIONS**

##### **A. Testing agency organization:**

1. Agencies testing construction materials: Meet requirements of ASTM E329.
2. Agencies testing concrete and concrete aggregates: Meet requirements of ASTM C1077.
3. Agencies testing soil and rock: Meet requirements of ASTM D3740.
4. Agencies testing bituminous paving materials: Meet requirements of ASTM D3666.
5. Agencies engaged in nondestructive testing: Meet requirements of ASTM E543.

##### **B. Equipment:**

1. Calibrate measuring devices, laboratory equipment, and instruments at established intervals.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

##### **3.01 CONTRACTOR QUALITY TESTING**

- ##### **A. Employ accredited independent agency to perform sampling, testing, and reporting as required in the following Sections:**
1. Section 03 30 00 – Cast-in-Place Concrete.
  2. Section 31 23 02 – Compacting Earth Materials.
  3. Section 31 23 70 – Controlled Low Strength Material (CLSM).
  4. Section 32 12 22 – Asphalt Concrete Pavement.
  5. Section 32 15 10 – Gravel Surfacing.
  6. Section 32 15 11 – Aggregate Base.
  7. Other sections as required.

### **3.02 GOVERNMENT CONTRACT QUALITY ASSURANCE**

- A. During the course of the work, Government may perform quality assurance tests. Tests performed by Government will be used to ensure compliance with contract requirements and not as replacement for specified Contractor quality testing.
1. Upon request, make measuring and testing devices available for use by Government for verification tests.
  2. If a conflict arises between Contractor quality testing results and Government quality assurance tests, Government testing results will take precedence over Contractor testing results.

**END OF SECTION**

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**SECTION 01 46 25**  
**SPECIAL INSPECTIONS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in applicable prices offered in the Price Schedules for items required to have Special Inspections.

**1.02 REFERENCE STANDARDS**

A. American Society Of Civil Engineers (ASCE):

1. ASCE 7 (2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures

B. International Code Council (ICC):

1. ICC IBC (2012) International Building Code

**1.03 DEFINITIONS**

A. Continuous Special Inspections:

1. Continuous Special Inspections is the constant monitoring of specific tasks by a special inspector. These inspections shall be carried out continuously over the duration of the particular tasks.

B. DFOW:

1. Definable Feature of Work.

C. Periodic Special Inspections:

1. Periodic Special Inspections are Special Inspections by special inspector who is intermittently present where the work to be inspected has been or is being performed.

D. Special Inspector (SI):

1. Qualified person retained by Contractor and approved by CO as having competence necessary to inspect a particular type of construction requiring Special Inspections. SI shall be an independent third party hired directly by Prime Contractor.

- E. Associate Special Inspector (ASI):
  - 1. Qualified person who assists SI in performing Special Inspections but shall perform inspection under direct supervision of SI and cannot perform inspections without SI on site.
- F. Third Party:
  - 1. Third party inspector shall not be a company employee of Contractor or any Subcontractor performing the work to be inspected, except in a certified manufacturing facility approved by COR.
- G. Special Inspector of Record (SIOR):
  - 1. Licensed engineer in responsible charge of supervision of all special inspectors for the project and approved by COR. SIOR shall be an independent third party hired directly by Prime Contractor.
- H. Statement of Special Inspections (SSI):
  - 1. Section identifying material, systems, components and work required to have Special Inspections.
- I. Schedule of Special Inspections:
  - 1. Schedule which lists each of the required Special Inspections, extent to which each Special Inspections is to be performed, and required frequency for each in accordance with ICC IBC Chapter 17.

#### **1.04 GENERAL REQUIREMENTS**

- A. Perform Special Inspections in accordance with this section and Chapter 17 of ICC IBC. For purposes of this contract, language of the ICC IBC will be revised as follows:
  - 1. "Owner" shall be considered "Government".
  - 2. "Building Official" shall be considered "COR or COR's representative":
    - a. It is the responsibility of Contractor to provide Special Inspection services for listed DFW's. All requirements of Special Inspection as outlined in ICC IBC are required to be provided, with the exception of entity required to provide services.
- B. Special Inspections shall be performed by an approved Testing Agency meeting technical requirements defined in IBC 1703.1.1 and this section.
- C. Special inspections do not replace Contractor's Quality Procedures/Quality Control (QC) Program or any testing and inspections required by other sections of specifications.
- D. Government will use results of Special Inspections and Testing as a means of validating Contractor's Quality Control Program and are intended to ensure that the work of prime contractor is in accordance with Contract Documents and applicable building codes.

- E. Special Inspections shall be the minimum inspection requirement for DFW's included in paragraph 1.04 Statement of Special Inspections. DFW Specification Sections may contain Project – Specific Inspection Requirements which shall be in addition to and take precedence over the minimum requirements listed in Section 01 46 25 – Special Inspections. COR will make final determination regarding requirements of Sections 01 46 00 – Quality Procedures, 01 46 20 – Testing Agency Services and 01 46 25 – Special Inspections requirements.

#### **1.05 STATEMENT OF SPECIAL INSPECTIONS**

- A. Special Inspections required for the following DFW's:
1. Concrete Forming, Section 03 11 10 – Concrete Forming
  2. Concrete Reinforcing, Section 03 20 00 – Concrete Reinforcing.
  3. Cast-In-Place Concrete, Section 03 30 00 – Cast-In-Place Concrete.
  4. Reinforced Concrete Unit Masonry Assemblies, Section 04 22 10 – Reinforced Concrete Unit Masonry Assemblies.
  5. Metal Building System, Section 13 34 21 – Metal Building System.
  6. Earthwork, Section 31 23 10 – Earthwork.

#### **1.06 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 46 25-1, Preconstruction Submittals:
1. SIOR Qualifications.
  2. SIOR Letter of Acceptance.
  3. Special Inspections Project Manual, Special Inspections Agency's Written Practices, NDT Procedures and Equipment Calibration Records.
- C. RSN 01 46 25-2, Test Reports:
1. Special Inspections Daily Reports.
  2. Special Inspections Biweekly Reports.
- D. RSN 01 46 25-3, Certificates:
1. Fabrication Plant(s).
  2. Steel Truss Plant.
  3. AC472 Accreditation.
  4. Steel Joist Institute Membership.
  5. Precast Concrete Institute (PCI).
  6. Certified Plant Certificate of Compliance.

7. Special Inspector of Record Qualifications.
8. Special Inspector Qualifications.
9. Qualification Records for NDT technicians.

E. RSN 01 46 25-4, Closeout Submittals:

1. Interim Final Report of Special Instructions.
2. Comprehensive Final Report of Special Instructions.

## 1.07 SPECIAL INSPECTOR QUALIFICATIONS

A. Special Inspections shall meet Qualifications of Applicable Certifying Associations.

Partial List of Certifying Associations

AABC	Associated Air Balance Council
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ASNT	American Society for Nondestructive Testing
AWS	American Welding Society
ICC	International Code Council
NICET	National Institute for Certification in Engineering Technologies
PCI	Precast/Prestressed Concrete Institute
UL	Underwriters Laboratories

B. Provide qualifications for each special inspector and special inspector of record.

C. Steel Construction and High Strength Bolting:

1. Special Inspector:
  - a. ICC Structural Steel and Bolting Special Inspector certificate with 1-year of related experience or,
  - b. Registered Professional Engineer with related experience.
2. Associate Special Inspector:
  - a. Engineer-In-Training with 1-year of related experience.

D. Welding Structural Steel:

1. Special Inspector:
  - a. Welding Structural Steel.
  - b. Special Inspector:
    - 1) ICC Structural Welding Special Inspector certificate with 1-year of related experience.
    - 2) AWS Certified Welding Inspector.
2. Associate Special Inspector:
  - a. AWS Certified Associate Welding Inspector.

- E. Nondestructive Testing of Welds:
  - 1. Special Inspector:
    - a. NDT Level III Certificate or equal approved by COR.
  - 2. Associate Special Inspector:
    - a. NDT Level II Certificate plus 1-year of related experience or equal approved by COR.
- F. Precast Concrete Construction:
  - 1. Special Inspector:
    - a. ICC Precast Special Inspector Certificate with 1-year of related experience or equal approved by COR.
    - b. PCI Quality Control Technician/Inspector Level II Certificate with 1-year of related experience or equal approved by COR.
- G. Sprayed Fire Resistant Material:
  - 1. Special Inspector:
    - a. ICC Spray-applied Fireproofing Special Inspector Certificate or equal approved by COR.
- H. Mastic and Intumescent Fire Resistant Coatings:
  - 1. Special Inspector:
    - a. ICC Spray-applied Fireproofing Special Inspector Certificate or equal approved by COR.
- I. Special Inspector of Record (SIOR).
  - 1. Licensed Professional Engineer in the State of California approved by COR.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 FABRICATOR SPECIAL INSPECTIONS**

- A. Special Inspections of fabricator's work performed in fabricator's shop is required to be inspected in accordance with Statement of Special Inspections and Schedule of Special Inspections unless fabricator is certified by approved agency to perform such work without Special Inspections. Provide the following certifications to COR, for information, to allow work performed in Fabricator's shop not to be subjected to Special Inspections:

1. American Institute of Steel Construction (AISC) Certified Fabrication Plant, Category STD.
  2. Truss Plate Institute (TPI) steel truss plant quality assurance program certification.
  3. Steel Joist Institute Membership.
  4. Precast Concrete Institute (PCI) Certified Plant, Group C.
- B. At completion of fabrication, provide a certificate of compliance, to be included with comprehensive final report of Special Inspections, stating that materials supplied and work performed by fabricator are in accordance with construction documents.

### **3.02 RESPONSIBILITIES**

- A. Special Inspector of Record:
1. Supervise all Special Inspectors required by specifications and IBC.
  2. Provide SIOR Letter of Acceptance to COR attesting to acceptance of duties of SIOR, signed and sealed by SIOR.
  3. Verify qualifications of all of Special Inspectors.
  4. Verify qualifications of fabricators.
  5. Provide Special Inspections agency's written practices for monitoring and control of agency's operations to include the following:
    - a. Agency's procedures for selection and administration of inspection personnel, describing training, experience and examination requirements for qualifications and certification of inspection personnel.
    - b. Agency's inspection procedures, including general inspection, material controls, and visual welding inspection.
  6. Provide qualification records for nondestructive testing (NDT) technicians designated for the project.
  7. Provide NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.
  8. Prepare Special Inspections Project Manual, which will cover the following:
    - a. Roles and responsibilities of the following individuals during Special Inspections: SIOR, SI, General Contractor, Subcontractors, and QC Manager.
    - b. Organizational chart and/or communication plan, indicating lines of communication.
    - c. Contractor's internal plan for scheduling inspections. Address items such as timeliness of inspection requests, who to contact for inspection requests, and availability of alternate inspectors.
    - d. Verify Government reporting procedures.

- e. Propose forms or templates to be used by SI and SIOR to document inspections.
  - f. Indicate procedures for tracking nonconforming work and verification that corrective work is complete.
  - g. Indicate how SIOR and/or SI will participate in weekly QC meetings.
  - h. Indicate how Special Inspections of shop fabricated items will be handled when Fabricator's Shop is not certified per paragraph Fabricator Special Inspections.
  - i. Include a section in manual that covers each specific item requiring Special Inspections that is indicated on Schedule of Special Inspections. Provide names and qualifications of each special inspector who will be performing Special Inspections for each specific item. Provide detail on how Special Inspections are to be carried out for each item so that expectations are clear for General Contractor and Subcontractor performing the work.
  - j. Make a copy of Special Inspections Project Manual available on the job site during construction. Provide a copy of Special Inspections Project Manual for approval.
9. Attend coordination and mutual understanding meeting where information in Special Inspections Project Manual will be reviewed to verify that all parties have a clear understanding of Special Inspections provisions and individual duties and responsibilities of each party.
  10. Maintain 3-ring binder for Special Inspector's daily and biweekly reports and Special Inspections Project Manual. File shall be located in a conspicuous place in project trailer/office to allow review by COR.
  11. Provide a copy of Special Inspector's daily reports to QC Manager.
  12. Discrepancies that are observed during Special Inspections shall be reported to QC Manager for correction. If discrepancies are not corrected before special inspector leaves the site observed discrepancies shall be documented in daily report.
  13. Provide biweekly Special Inspections report until all work requiring Special Inspections is complete. A report is required for each biweekly period in which Special Inspections activity occurs, and shall include the following:
    - a. Brief summary of work performed during reporting time frame.
    - b. Changes and/or discrepancies with drawings, specifications and mechanical or electrical component certification that were observed during reporting period.
    - c. Discrepancies which were resolved or corrected.
    - d. List of nonconforming items requiring resolution.
    - e. All applicable test results including nondestructive testing reports.

14. At completion of each DFOW requiring Special Inspections, provide interim final report of Special Inspections that documents Special Inspections completed for that DFOW and corrections of all discrepancies noted in daily reports. Interim final report of Special Inspections shall be signed, dated and bear the seal of SIOR.
15. At completion of the project provide comprehensive final report of Special Inspections that documents Special Inspections completed for the project and corrections of all discrepancies noted in daily reports. Comprehensive final report of Special Inspections shall be signed, dated and bear the seal of SIOR.

B. Special Inspectors:

1. Inspect all elements of the project for which special inspector is qualified to inspect and are identified in Schedule of Special Inspections.
2. Attend preparatory phase meetings related to DFOW for which special inspector is qualified to inspect.
3. Provide Special Inspections agency's written practices for monitoring and control of agency's operations to include the following:
  - a. Agency's procedures for selection and administration of inspection personnel, describing training, experience and examination requirements for qualifications and certification of inspection personnel.
  - b. Agency's inspection procedures, including general inspection, material controls, and visual welding inspection.
4. Provide qualification records for NDT technicians designated for the project.
5. Provide NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.
6. Provide copy of daily reports to QC Manager.
7. Discrepancies that are observed during Special Inspections shall be reported to QC Manager for correction. If discrepancies are not corrected before special inspector leaves site observed discrepancies shall be documented in daily report.
8. Provide biweekly Special Inspection Report until all inspections are complete. Report is required for each biweekly period in which Special Inspections activity occurs, and shall include the following:
  - a. Brief summary of work performed during reporting time frame.
  - b. Changes and/or discrepancies with drawings, specifications and mechanical or electrical component certification that were observed during reporting period.
  - c. Discrepancies which were resolved or corrected.
  - d. List of nonconforming items requiring resolution.
  - e. All applicable test result including nondestructive testing reports.

9. At completion of each DFW requiring Special Inspections, provide interim final report of Special Inspections that documents Special Inspections completed for that DFW. Identify inspector responsible for each item inspected and corrections of all discrepancies noted in daily reports. Interim final report of Special Inspections shall be signed, dated and indicate certification of special inspector qualifying them to conduct inspection.
10. At completion of the project provide a comprehensive final report of Special Inspections that documents Special Inspections completed for the project and corrections of all discrepancies noted in daily reports. Comprehensive final report of Special Inspections shall be signed, dated and indicate certification of special inspector qualifying them to conduct inspection.
11. Provide daily reports to SIOR.

### **3.03 DEFECTIVE WORK**

- A. Check work as it progresses, but failure to detect any defective work or materials must in no way prevent later rejection if defective work or materials are discovered, nor obligate CO to accept such work.

**END OF SECTION**

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**SECTION 01 51 00**  
**TEMPORARY UTILITIES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C2-12 National Electrical Safety Code (NESC)

**1.03 SUBMITTALS**

A. RSN 01 51 00-1, Water Storage:

1. Location and method of water storage:
  - a. Include drawing showing location and dimensions.
  - b. Travel route from water source to and from worksite.
  - c. Culturally clear and meet environmental requirements for road maintenance and/or minor improvements.
  - d. Provide agreement with entity providing water.

**1.04 TEMPORARY ELECTRICITY**

- A. Provide all electric power required for construction, testing and commissioning through contract completion and acceptance by Government.
- B. Provide all generators, transmission lines, distribution circuits, transformers, and other electrical equipment and facilities required for obtaining power and distributing power to points of use.
- C. Contractor is responsible for making all arrangements and payments to Utility Companies for all temporary electricity required for construction, testing and commissioning through contract completion and acceptance by Government.
- D. Comply with IEEE C2 clearances and spacing for temporary communications and supply lines.

E. Potential Sources:

1. Depending on availability the following entities may have electricity:

a. Pumping Plant No. 4:

1) Navajo Tribal Utility Authority (NTUA)

a) Contact:

Navajo Tribal Utility Authority  
P.O. Box 1749  
Shiprock, NM 87420  
Telephone: 1-800-528-5011  
[www.ntua.com](http://www.ntua.com)

b. Pumping Plant No. 7:

1) Navajo Tribal Utility Authority (NTUA):

a) Contact:

NTUA Fort Defiance District Office  
P.O. Box 587  
Fort Defiance, AZ 86504  
Telephone: 1-800-528-5011  
[www.ntua.com](http://www.ntua.com)

## 1.05 TEMPORARY WATER

A. Provide all water required for construction, testing and commissioning through contract completion and acceptance by Government.

B. Potential Sources:

1. Depending on availability the following entities may have potable water:

2. Contact for access, metering, and billing arrangements.

a. Navajo Tribal Utility Authority (NTUA)”

1) Contact:

Navajo Tribal Utility Authority  
P.O. Box 170  
Fort Defiance, AZ 86504  
Telephone: 800-528-5011  
[www.ntua.com](http://www.ntua.com)

b. Navajo Department of Water Resources (NDWR) may have non-potable construction water:

1) Contact:

Navajo Nation Department of Water Resources (NDWAR)  
O&M Branch Director: Raymond Benally  
P.O. Box 678  
Fort Defiance, AZ 86504  
Telephone: 928-729-4003  
[www.nndwr.navajo-nsn.gov/](http://www.nndwr.navajo-nsn.gov/)

c. Navajo Nation Water Code Administration (NNWCA) may have non-potable construction water:

1) Pumping Plant No. 4

a) Contact:  
Navajo Nation Water Code Administration  
P.O. Box 678  
Fort Defiance, AZ 86504  
Attn: Melvin Badonie Shiprock Field Office  
Telephone: 505-368-1426  
[www.watercode.navajo-nsn.gov](http://www.watercode.navajo-nsn.gov)

2) Pumping Plant No. 7

a) Contact:  
Navajo Nation Water Code Administration  
P.O. Box 678  
Fort Defiance, AZ 86504  
Attn: Laurita Begay  
Telephone: 928-729-4132  
Fax: 928-729-4421  
[www.watercode.navajo-nsn.gov](http://www.watercode.navajo-nsn.gov)

C. Arrange, pay and transport water for use during construction:

1. Provide proof of payment to water utility.

D. Use water which meets specified requirements for water used in concrete, soil-cement, masonry, grouting, and other permanent work.

E. Furnish means of conveying water to points of use.

## **1.06 TEMPORARY SANITARY FACILITIES**

A. Provide temporary sanitary facilities.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 REMOVAL**

A. Remove temporary equipment and facilities upon completion of work under this contract.

**END OF SECTION**

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**SECTION 01 55 00**  
**VEHICULAR ACCESS AND PARKING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REGULATORY REQUIREMENTS**

- A. Meet requirements established by jurisdictional authority for use of existing roadways and haul routes; including seasonal or other limitations or restrictions, payment of excess size and weight fees, and posting of bonds conditioned upon repair of damage.
- B. Comply with applicable regulations for haul routes over public highways, roads, or bridges.

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

1. RSN 01 55 00-1, Pre-Construction Digital Recording:
  - a. Include roads, driveways, corrals, cattle guards, fences, and other areas as directed by COR.
2. RSN 01 55 00-2, Post Construction and Post Repair Digital Recording.

**1.04 SITE CONDITIONS**

- A. Establish rights-of-way for access to work from existing roads.
1. In accordance with clause at FAR 52.236-10, Operations and Storage Areas, use only established roadways, parking areas, and haul routes; or temporary roadways, parking areas, or haul routes constructed by Contractor when and as authorized by CO.
  2. Subject to clause at FAR 52.249-10, Default (Fixed-Price Construction), unavailability of transportation facilities or limitations thereon shall not become a basis for claims for damages or extension of time for completion of work.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Materials to maintain and repair existing roadways, parking areas, and haul routes: In accordance with requirements of jurisdictional authority.
- B. Materials to construct, maintain, and repair temporary roadways, parking areas, and haul routes: As approved by COR.
- C. Materials to maintain roadways and parking areas constructed under this contract and used by Contractor for construction work: In accordance with specified requirements for construction of those roadways and parking areas.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Investigate condition of available public or private roads for clearances, restrictions, bridge-load limits, bond requirements, and other limitations that affect or may affect access and transportation operations to and from jobsite.

### **3.02 RECORDS**

- A. Make pre-construction, post construction, and post repair digital recordings as directed by COR.
  - 1. DVD format with a minimum 720p resolution.
  - 2. Label:
    - a. Contract number and title.
    - b. Contractor's name.
    - c. Date recording is made.
    - d. Preface video with this information.
- B. COR will be present during recording. Notify COR at least 3-days prior to recording.

### **3.03 ESTABLISHED ROADWAYS AND PARKING AREAS**

- A. Established roadways and parking areas are available for Contractor's use subject to existing restrictions and approval of COR.

### **3.04 TEMPORARY ROADWAYS AND PARKING AREAS**

- A. Roadways:

1. Construct temporary roadways for access from public thoroughfares to serve construction area, of a width and load-bearing capacity to provide unimpeded traffic for construction purposes.
2. Construct temporary bridges or culverts at stream crossings or cross-drainage channels to allow for unimpeded surface drainage.

**B. Parking Areas:**

1. Construct temporary parking areas to accommodate use of construction personnel.
2. Provide additional offsite parking when site space is not adequate.
3. Locate as indicated on drawings.

**3.05 HAUL ROUTES**

- A. Perform work on established rights-of-way as necessary to construct and maintain any roads, bridges, or drainage structures required for establishment and use of haul routes for construction operations.
- B. Use existing available public highways, roads, or bridges as haul routes subject to applicable local regulations.
- C. Minimize interference with or congestion of local traffic.
- D. Provide barricades, flaggers, and other necessary precautions for safety of public where haul routes cross public highways or roads in accordance with Section 01 55 20 – Traffic Control.
- E. Detours: In accordance with Section 01 55 20 – Traffic Control.

**3.06 MAINTENANCE**

- A. Maintain roadways, parking areas, and haul routes in a sound, smooth condition in accordance with these specifications and Jurisdictional Authorities.
- B. Maintain surfacing of gravel surfaced roads and parking areas until completion and acceptance of work under this contract. As approved by COR, defer until latest practicable date within specified completion period, placement of surfacing on roads or parking areas subject to heavy and deteriorating use by Contractor's construction operations or equipment in accordance with these specifications and Jurisdictional Authorities.
- C. Snow removal for convenience of Contractor or to facilitate work operations of Contractor is considered to be normal required maintenance.

### 3.07 REPAIR

- A. Promptly repair ruts, broken pavement, potholes, low areas with standing water, and other deficiencies to maintain road surfacing and drainage in original or specified condition in accordance with these Specifications and Jurisdictional Authorities.
- B. Notify contact below prior to making improvements.
1. New Mexico 811:  
1021 Eubank Blvd NE  
Albuquerque, NM 87112  
[www.nmonecall.org](http://www.nmonecall.org)  
Statewide: Dial 811  
or 800-321-ALERT (2537) during regular business hours.  
By Fax: (505)260-1248 or (800)727-8809 24 Hours a day.  
By Web: Request a Line Spot 24 Hours a day.
  2. Navajo Nation Division of Transportation:  
777 US-491  
Shiprock, NM 87420  
[www.navajodot.org](http://www.navajodot.org)  
Telephone: 505-371-8300/8301  
Fax: 505-371-8399
  3. Pumping Plant No. 4:  
San Juan County Roads Department  
305 South Oliver Drive  
Aztec, NM 87410  
[www.sjcounty.net/departments/hthnuz/public-works](http://www.sjcounty.net/departments/hthnuz/public-works)  
Telephone: 505-334-4520
  4. Pumping Plant No. 7:  
Mc Kinley County Roads Department  
1980 Warehouse Lane  
Gallup, NM 87301  
[www.co.mckinley.nm.us/164/roads](http://www.co.mckinley.nm.us/164/roads)  
Telephone: 505-722-2303  
Fax: 505-722-9380

### 3.08 REMOVAL

- A. Remove materials used to construct temporary roadways, parking areas, and haul routes prior to contract completion. Recycle salvageable materials as approved by COR.

**END OF SECTION**

**SECTION 01 55 20**  
**TRAFFIC CONTROL**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for other items of work, except water for dust abatement.
- B. See Section 31 02 10 – Water for Dust Abatement for measurement and payment of water for Dust Abatement.

**1.02 REFERENCE STANDARDS**

- A. Federal Highway Administration (FHWA)
1. MUTCD, Part 6 Part 6, Temporary Traffic Control, Manual on Uniform Traffic Control Devices, 2009 Edition with Revisions 1 and 2,  
[http://mutcd.fhwa.dot.gov/kno\\_2009r1r2.htm](http://mutcd.fhwa.dot.gov/kno_2009r1r2.htm)

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 55 20-1, Traffic Control Plan and Permit Applications:
1. Pumping Plant No. 4:
    - a. Submit completed NMDOT permit applications to Government for approval before submitting permit to NMDOT.
  2. Pumping Plant No. 7:
    - a. Submit completed Navajo Nation Division of Transpiration (NNDOT) permit applications to Government for approval before submitting permit to NNDOT.
- C. RSN 01 55 20-2, Permits:
1. Provide copy of signed and approved permits from NMDOT and NNDOT.

**1.04 PROJECT CONDITIONS**

- A. Project includes:
1. Pumping Plant No. 4:
    - a. Working in New Mexico Department of Transportation (NMDOT) ROW as shown on drawings.

2. Pumping Plant No. 7:
  - a. Working in Navajo Nation Department of Transportation (NNDOT) ROW as shown on drawings.
- B. NMDOT and NNDOT have approved project in concept, but Government has not applied for or obtained permits for work.
- C. Contractor shall obtain permits required by NMDOT and NNDOT.
- D. NMDOT and NNDOT Permit applications for utility crossings are included in Section 51 00 10 – Permit Application. NMDOT and NNDOT may require more information than shown on permit applications.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 TRAFFIC CONTROL**

- A. Meet requirements of NMDOT permit and MUTCD, Part 6, RSHS and Jurisdictional Authorities.
- B. Provide cones, delineators, concrete safety barriers, barricades, flasher lights, danger signals, signs, and other temporary traffic control devices as required to protect work and public safety.
- C. Provide flaggers and guards as required to prevent accidents and damage or injury to passing traffic.
- D. Do not begin work along public or private roads until proper traffic control devices for warning, channeling, and protecting motorists are in place in accordance with approved traffic control plan.
- E. Maintain traffic flow and conduct construction operations to minimize obstruction and inconvenience to public traffic.
- F. Provide unobstructed, smooth, and dustless passageway for two lane of traffic through construction operations.
- G. Maintain convenient access to driveways, houses, and buildings along line of work.
- H. Protect roads closed to traffic with effective barricades and warning signs. Illuminate barricades and obstructions from sunset to sunrise.
- I. Remove traffic control devices when no longer needed.

**END OF SECTION**

**SECTION 01 56 15**  
**PROTECTION OF EXISTING UTILITIES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for other items of work except for Underground Utility Line Investigations and Power Pole Relocation and/or Monitoring During Construction.
- B. Underground Utility Line Investigations:
1. Payment: Lump sum price offered in the Price Schedules.
- C. Power Pole Relocation and/or Monitoring During Construction:
1. Measurement: Number of Relocated and/or Monitored Power Poles.
  2. Payment: Unit prices offered in the Price Schedules:
    - 1) All items associated with relocation and/or monitoring power poles as shown in 51 00 30 – Utility Acknowledgements.

**1.02 REFERENCE STANDARDS**

- A. Bureau of Reclamation (Reclamation)
1. RSHS Reclamation Safety and Health Standards, including revisions posted at: [www.usbr.gov/ssle/safety/RSHS/rshs.html](http://www.usbr.gov/ssle/safety/RSHS/rshs.html)
- B. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE C2-12 National Electrical Safety Code (NESC)

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 56 15-1, Utility Owner Acknowledgement:
1. Copy of notification acknowledgement showing underground and overhead utility agreements.
- C. RSN 01 56 15-2, Underground Utility Line Investigations:
1. Include the following information for each utility line as applicable:
    - a. Owner company name, address, and telephone number.

- b. Utility line crossing location along pipeline alignment.
  - c. Utility line material.
  - d. Elevation.
  - e. Diameter.
  - f. Service restrictions.
  - g. Powerline voltage.
- D. RSN 01 56 15-3, Work Plan within Utility Easements:
- 1. Proposed installation method including construction equipment.
  - 2. Methods for protecting.
  - 3. Approval of work plan from Utility owner.

#### **1.04 PROJECT CONDITIONS**

- A. Drawings included in these specifications show existing utilities, but may not show all utilities existing at jobsite.
- B. Unknown existing utility lines may cross and/or parallel pumping plant yards and pipeline alignments.
- C. Government does not represent that location of known existing utilities shown on drawings are exact. It is Contractor's responsibility to determine actual location of and make provision for all known and unknown utilities:
  - 1. Verify locations, depths and clearances of both above and below ground utilities prior to excavation.
- D. Ensure that each utility line is in service as required by each utility owner.
- E. Contractor shall coordinate work within existing pipeline and transmission line Rights-of-Way with all utility owners. Contractor's shall comply with all Utility owner crossing requirements and shall be responsible for all costs associated with utility crossings. Obtain permission from Utility owners before procuring materials to be installed in Right-of-Way.

#### **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Have New Mexico One Call 811 locate utilities before doing underground work.
- B. Navajo Tribal Utility Authority (NTUA) is not part of New Mexico One Call.
  - 1. Have NTUA locate utilities before doing underground work. Contact Information:  
Navajo Tribal Utility Authority (NTUA)  
P.O. Box 170  
Fort Defiance, AZ 86504  
Telephone: 800-528-5011
- C. Utility Crossing Investigation:
  - 1. Determine height of overhead utility heights and clearances.
  - 2. Determine by potholing or test pits, location, elevations, diameters, and materials of each underground utility line.
  - 3. Obtain permission from utility owner before performing physical utility investigation (potholing or test pits).
- D. Coordinate with each utility line owner and schedule construction to adhere to each owner's in service, allowable out of service, and crossing requirements during construction. No excavation will be permitted in vicinity of gas lines when in service without written approval from Gas Company.
- E. Notify impacted property owner at least 2 working days before disturbing waterline that serves their property. Water service to property shall not be shut off for more than 8-hours.
- F. Protect and support existing utilities that intersect work area. Before commencing work, obtain approval and necessary permits from utility owners within project ROW.
  - 1. Protect overhead power facilities as required by NTUA if working in their ROW.
  - 2. Protect existing waterlines as required by NTUA when working within 100-feet of their lines.
- G. Repair existing utilities damaged during construction as approved by COR and utility owner.

### **3.02 POWER POLE RELOCATION AND/OR MONITORING DURING CONSTRUCTION**

- A. Refer to Table 51 00 30C – Power Poles for information about relocating and/or monitoring power poles during construction.

**3.03 CLEARANCE**

- A. Obtain clearances required for construction operations: Contractor shall provide in accordance with RSHS.

**3.04 INTERFERENCE WITH OPERATION OR MAINTENANCE**

- A. Do not interfere with operation or maintenance service on utilities, existing on date offers are received:
  - 1. Provide for access to utilities in a manner satisfactory to owners and operators and Government.
- B. Provide required temporary structures; make necessary repairs, replacements, or similar operations; and furnish indemnity or other bonds.

**END OF SECTION**

**SECTION 01 56 20**  
**EXISTING FENCES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Rebuild fence with new material unless otherwise approved by COR.
- B. Provide replacement materials of similar type, when available.

**PART 3 EXECUTION**

**3.01 FENCE REMOVAL**

- A. Remove existing fences where necessary for performance of work, only when authorized by COR. Coordinate with chapter grazing official to offer the opportunity for grazing permit lessee(s) to be present when fence is cut to ensure fence is adequately braced and secured. Maintain fences, where designated, until work is completed or their removal is authorized.

**3.02 TEMPORARY FENCES**

- A. Where fences are removed on rights-of-way, provide temporary fence protection for adjacent lands to prevent livestock from straying from or onto adjacent lands, complete with gates and cattle guards.
- B. If Contractor does not provide necessary temporary fencing or protection within a reasonable time after need for fencing or protection arises, CO will cause work to be performed and backcharge Contractor for such work.
- C. Remove temporary fences and protection as a part of cleanup operations prior to final acceptance of completed work.

**3.03 FENCE REBUILDING**

- A. Where fences are removed to accommodate construction, rebuild at original locations.

- B. Construct rebuilt fencing that is structurally sound and matches, or is better than, existing fencing installation.

**END OF SECTION**

**SECTION 01 56 32**  
**TEMPORARY SAFETY FENCE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**PART 2 PRODUCTS**

**2.01 SAFETY FENCE**

A. Fence:

1. High-density polyethylene grid.
2. Minimum height: 48-inch.
3. Color: Safety orange.
4. Recovered Material Content:
  - a. 90 to 100 percent.
5. Postconsumer Content:
  - a. 60 to 100 percent.

B. Posts: Steel fence posts.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Erect fence around work areas at location approved by COR.
- B. Space posts 10-foot, maximum, on center.
- C. Secure grid to posts.

**3.02 MAINTENANCE AND REMOVAL**

- A. Maintain fence until work in area is complete and accepted by COR.
- B. Remove fence when no longer required.

**END OF SECTION**

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**SECTION 01 57 10**  
**CROSS DRAINAGE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work:
  - a. Damage due to Contractor's negligence or lack of appropriate controls shall be repaired at Contractor's expense.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. Flows from natural drainage channels intercepted by work shall be controlled.
- B. Provide and maintain temporary construction required to control, bypass, or otherwise cause flows to be harmless to work and to public or private property.
- C. Perform additional ditching and grading for drainage as directed by COR.
- D. Remove temporary construction and restore site to original condition, as approved by COR, when temporary construction is no longer needed and prior to acceptance of work.
- E. Return drainage to original grade and slope once pipe is in place and backfilled.
- F. Damage to work under these specifications and to public or private property shall be restored to original condition, as approved by COR, at Contractor's expense.

**END OF SECTION**

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**SECTION 01 57 20**  
**ENVIRONMENTAL CONTROLS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for other items of work, except as specified.
  2. Costs for damages and work stoppage are Contractor's responsibility.
- B. See Section 31 02 10 – Water for Dust Abatement, for measurement and payment for applying water used for dust abatement within rights-of-way.
- C. See Section 31 02 30 – Dust Palliative, for measurement and payment for applying dust palliative within rights-of-way.

**1.02 REFERENCE STANDARDS**

- A. Bureau of Reclamation (Reclamation)
1. RSHS Reclamation Safety and Health Standards,  
including revisions posted at:  
[www.usbr.gov/ssle/safety/RSHS/rshs.html](http://www.usbr.gov/ssle/safety/RSHS/rshs.html)
- B. Navajo OSHA
1. Navajo OSHA Sawnevan Dale; (928) 871-6742  
[www.sdale@mosha.org](mailto:www.sdale@mosha.org)

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 57 20-1, Copy of Applicable Air Quality Permit.

**1.04 REGULATORY REQUIREMENTS**

- A. Comply with Federal, Tribal, State, and local laws and regulations.
- B. Comply with RSHS.
- C. Conform to most stringent requirement in cases of conflict between specifications, regulatory requirements, and RSHS.

- D. Contractor shall be responsible for damages resulting from dust originating from Contractor operations in accordance with clause at FAR 52.236-7, "Permits and Responsibilities".
- E. CO may stop construction activity in violation of Federal, Tribal, State, or local laws and additional expenses resulting from work stoppage will be responsibility of Contractor.

#### **1.05 PERMITTING**

- A. Develop draft environmental permit applications not covered in other sections and forward to COR for review and submission by Government to relevant authorities having jurisdiction.

#### **1.06 DUST CONTROL**

- A. Provide dust control and abatement during performance of work, as approved by COR.
- B. Prevent, control, and abate dust pollution on rights-of-way provided by Government or elsewhere during performance of work.
- C. Provide labor, equipment, and materials, and use efficient, environmentally acceptable methods to prevent dust nuisance or damage to persons, property, or activities, including, but not limited to, crops, cultivated fields, wildlife habitats, dwellings and residences, agricultural activities, recreational activities, traffic, and similar conditions.
- D. Provide means for eliminating atmospheric discharges of dust during mixing, handling, and storing of cement, pozzolan, and concrete aggregate.

#### **1.07 AIR POLLUTION CONTROL**

- A. Air Quality Permits are not required for control of fugitive dust generated as result of construction-related activities on a short term basis, however permits are required with specific emission sources tied to aggregate processing and batch plant operations releasing particulates to atmosphere.
- B. Air Quality Permits are required for certain construction-related activities including, but not limited to, sandblasting, aggregate processing, or other processes which discharge pollutants into open air.
- C. Air Quality Permits, and information concerning requirements, are available from: New Mexico Environmental Department, telephone: 505-827-2855 and the USEPA.
- D. Use reasonably available methods and devices to prevent, control, and otherwise minimize atmospheric emissions or discharges of air contaminants.
- E. Do not operate equipment and vehicles that show excessive exhaust gas emissions until corrective repairs or adjustments reduce such emissions to acceptable levels.

**1.08 NOISE CONTROL**

- A. Only construction activities approved by COR will be allowed between dusk and dawn.

**1.09 LIGHT CONTROL**

- A. Shine direct stationary floodlights downward at an angle less than horizontal.
- B. Shield floodlights so that floodlights will not be a nuisance to surrounding areas.
- C. Direct lighting so that residences are not in direct beam of light.
- D. Correct lighting control problems when they occur as approved by COR.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

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**SECTION 01 57 30**  
**WATER POLLUTION CONTROL**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. Bureau of Reclamation (Reclamation)

1. RSHS Reclamation Safety and Health Standards, including revisions posted at:  
[www.usbr.gov/ssle/safety/RSHS/rshs.html](http://www.usbr.gov/ssle/safety/RSHS/rshs.html)

B. Navajo OSHA

1. Navajo OSHA Sawnevan Dale; (928) 871-6742  
[www.sdale@mosha.org](mailto:www.sdale@mosha.org)

C. Code of Federal Regulations (CFR)

1. 40 CFR, Part 112 Oil Pollution Prevention

D. Public Law

1. Sections 311, 402, and 404 Clean Water Act (Public Law 92-500, as amended)

E. U.S. Environmental Protection Agency (USEPA)

1. EPA CGP-17 Stormwater Discharge Permit associated with a Construction Site including revisions.  
[www.epa.gov/npdes/epas-2012-construction-general-permit-cgp-and-related-document](http://www.epa.gov/npdes/epas-2012-construction-general-permit-cgp-and-related-document)
2. EPA Developing a SWPPP SWPPP template and instructional resources available at:  
[www.epa.gov/npdes/developing-stormwater-pollution-prevention-plan-swppp](http://www.epa.gov/npdes/developing-stormwater-pollution-prevention-plan-swppp)

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.

- B. RSN 01 57 30-1, Updated Stormwater Pollution Prevention Plan (SWPPP):
  - 1. Modifications to draft SWPPP shall comply with requirements outlined in part 7 of Construction General Permit (CGP), dated 2012.
  - 2. Include copy of permits.
- C. RSN 01 57 30-2, Spill Prevention, Control, and Countermeasure (SPCC) Plan:
  - 1. Submit to COR when SPCC Plan is required in accordance with 40 CFR, Part 112:
  - 2. SPCC Plan is required where release of oil and oil products could reasonably be expected to enter into or upon navigable waters of the United States or adjoining shorelines in quantities that may be harmful (40 CFR, Part 110), and aggregate on site oil storage capacity is over 1,320-gallons. Only containers with capacity of 55-gallons and greater are included in determining on site aggregate storage capacity.
  - 3. Reviewed and certified by a registered professional engineer in accordance with 40 CFR, Part 112, as required by section 311 of the Clean Water Act (Public Law 92-500 as amended):
  - 4. Submit spill prevention plan for oil storage equal to or greater than 1,320 gallons. Spill Prevention Plan shall be stamped by a professional engineer to BOR for formal submittal and include:
    - a. Oil Storage Quantity.
    - b. Drawings of containment system.
    - c. Response plan to spill.

#### **1.04 REGULATORY REQUIREMENTS**

- A. Construction Safety Standards:
  - 1. Comply with sanitation and potable water requirements of section 7 of RSHS.
- B. Laws, Regulations, and Permits:
  - 1. Perform construction operations to comply, and ensure subcontractors comply, with:
    - a. Applicable Federal, State, Tribal, and local laws, orders, regulations, and Water Quality Standards concerning control and abatement of water pollution; and terms and conditions of applicable permits issued by permit issuing authority.
    - b. If conflict occurs between Federal, State, Tribal, and local laws, regulations, and requirements, the most stringent shall apply.

C. Contractor Violations:

1. If noncompliance should occur, verbally report noncompliance within 2-hours to CO. Submit specific written information within 24-hours including corrective actions.
2. Violation of applicable Federal, State, Tribal, or local laws, orders, regulations, or Water Quality Standards may result in CO stopping site activity until compliance is ensured.
3. Contractor shall not be entitled to extension of time, claim for damage, or additional compensation by reason of such a work stoppage.
4. Corrective measures required to bring activities into compliance shall be at Contractor's expense.

## 1.05 REQUIRED PERMITS

A. Wastewater Discharge Permit:

1. Permit:
  - a. Prior to discharging wastewater or other pollutants, provide draft permit(s) to discharge pollutants as required under section 402 of Clean Water Act (Public Law 92-500 as amended), and New Mexico Environment Department, Surface Water Quality Bureau and Navajo Nation Environmental Protection Agency.
  - b. Submit permit applications to Government, for review and Government's submittal.
  - c. Government will support Contractor in obtaining permits, as deemed appropriate by Government.
2. Terms and Conditions: Comply with terms and conditions as stated in permit.
3. Monitoring and Treatment:
  - a. Provide monitoring and water treatment to achieve compliance with permit conditions.
  - b. Provide recordkeeping required of permittee, as stated in Section 402 permit.
4. Sampling: Include sampling in monitoring required of Contractor to meet Section 402 requirements, as well as required laboratory tests to determine effluent characteristics.
5. Monitoring Results:
  - a. Provide monitoring results to appropriate agency as required by permit.
  - b. Send copies of information transmitted to appropriate agency to COR.

B. Stormwater Discharge Permit Associated with a Construction Site (EPA Construction general permit (CGP)):

1. Stormwater Pollution Prevention Plan (SWPPP):
  - a. Government will submit the plan drafted by Contractor.
  - b. Comply with terms and conditions to maintain CGP.
2. Notice of Intent (NOI):
  - a. Both Government and Contractor shall submit a NOI to obtain coverage under CGP.
  - b. Submit NOI via the EPS's eNOI system (go to [www.epa.gov/npdes/electronic-notice-intent-eno](http://www.epa.gov/npdes/electronic-notice-intent-eno))
    - 1) To obtain coverage under construction general permit to control stormwater and certain regulated non-stormwater discharges associated with construction activity including construction dewatering.
    - 2) Outlined in Part 1 of Final 2012 CGP required under provisions of Clean Water Act, 33 U.S.C. § 1251.
    - 3) Amended by Water Quality Act of 1987 (P.L. 100-4).
3. Monitoring and Water Treatment:
  - a. Provide monitoring and water treatment to achieve compliance with applicable Water Quality Standards and CGP.
  - b. Provide recordkeeping required by CGP associated with construction activity.

C. Stormwater Discharge Permit Associated with Industrial Activity:

1. Stormwater Discharge Permit:
  - a. If construction activities will entail use of a mobile CLSM plant, concrete plant, or nonmetallic borrow areas, a stormwater discharge permit associated with industrial activity may be required.
2. Terms and Conditions:
  - a. Comply with terms and conditions to obtain and maintain industrial stormwater discharge permit, including preparation of a Pollution Prevention Plan.
3. Monitoring and Water Treatment:
  - a. Provide monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards.
  - b. Provide recordkeeping required by stormwater discharge permit associated with industrial activity.

- D. 404 Permit and 401 Water Quality Certifications:
1. Government will apply for a permit to discharge dredged or fill material into waters of the United States (including wetlands) as required under section 404 of Clean Water Act (Public Law 92-500 as amended).
  2. If a 404 permit is required, Government will obtain a CWA 401 water quality certification from regulatory authority(s) having jurisdiction: NMED NNEPA and/or USEPA.
  3. Contractor shall:
    - a. Coordinate with Government and meet requirements of 404 permit and water quality certifications.
    - b. Provide documentation to support permit application, monitoring and close out.

## **1.06 CONTRACTOR RESPONSIBILITIES**

- A. Permits: Obtain permits in Government and Contractor's name.
- B. Monitoring:
1. Conduct monitoring in order to meet requirements of permits which may include:
    - a. Sampling,
    - b. Site inspections,
    - c. Required laboratory tests to determine effluent characteristics.
- C. Reporting Results:
- a. Provide monitoring results to appropriate agency as required by permit.
  - b. Send copies of information transmitted to appropriate agency to COR.
- D. Recordkeeping: Retain records and data for life of project or as required by permits, whichever is longer.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 POLLUTION CONTROLS**

- A. Control pollutants by use of sediment and erosion controls, wastewater and stormwater management controls, construction site management practices, and other controls including Federal, Tribal State and local control requirements. As shown on approved SWPPP and as necessary to control pollutants.
  
- B. Sediment and Erosion Controls:
  - 1. Establish methods for controlling sediment and erosion which address vegetative practices, structural control, sediment controls, and operator controls as appropriate.
  - 2. Institute stormwater management measures as required, including velocity dissipators, and solid waste controls which address controls for building materials and offsite tracking of sediment.
  
- C. Wastewater and Stormwater Management Controls:
  - 1. Pollution prevention measures:
    - a. Use methods of dewatering, unwatering, excavating, or stockpiling earth and rock materials which include prevention measures to control silting and loss of soil due to wind and water erosion, and which will intercept and settle runoff of sediment-laden waters.
    - b. Prevent wastewater from general construction activities such as drainwater collection, aggregate processing, concrete batching, and drilling, grouting, or other construction operations, from entering flowing or dry watercourses without the use of approved turbidity control methods.
    - c. Divert stormwater runoff from upslope areas away from disturbed areas.
  - 2. Turbidity Prevention Measures:
    - a. Use methods for prevention of excess turbidity which include, but are not restricted to, intercepting ditches, settling ponds, gravel filter entrapment dikes, flocculating processes, recirculation, combinations thereof, or other approved methods that are not harmful to aquatic life.
    - b. Wastewaters discharged into surface waters shall meet conditions of permits.
    - c. Do not operate mechanized equipment in waterbodies without having first obtained a section 404 permit and 401 water quality certifications, and then only as necessary to construct crossings or perform required construction.

D. Construction Site Management:

1. Contractor construction operations:
  - a. Perform construction activities by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, or other pollutants or wastes into streams, flowing or dry watercourses, lakes, wetlands, reservoirs, or underground water sources:
    - 1) Pollutants and wastes include, but are not restricted to: refuse, garbage, cement, sanitary waste, industrial waste, hazardous materials, radioactive substances, oil and other petroleum products, aggregate processing tailings, mineral salts, and thermal pollution.
  - b. Comply with 404 permit and 401 water quality certifications.
2. Stockpiled or deposited materials:
  - a. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff, or can encroach upon watercourse.
3. Petroleum product storage tanks management:
  - a. Place oil or other petroleum product storage tanks at least 100-feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and other water sources. Do not place petroleum product storage tanks within a watercourse's 100-year floodplain.
  - b. Do not use underground storage tanks.
  - c. Construct storage area dikes at least 12-inches high or graded and sloped to permit safe containment of leaks and spills equal to storage tank capacity located in the area plus sufficient freeboard to contain 25-year rainstorm:
    - 1) Line diked areas with an impermeable barrier at least 50 mils thick.
  - d. Areas for refueling operations: Lined with impermeable barrier at least 10 mils thick covered with 2- to 4-inches of soil.

**END OF SECTION**

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**SECTION 01 57 40**  
**PESTICIDES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.
2. Contractor is responsible for damages resulting from use of pesticides under these specifications in accordance with the clause at FAR 52.236-7, "Permits and Responsibilities".

**1.02 DEFINITIONS**

- A. Pesticides: Includes herbicides, insecticides, fungicides, rodenticides, piscicides, avicides, surface disinfectants, animal repellants, and insect repellants.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 01 57 40-1, Pest Management/Integrated Pest Management Checklist:

1. Not required for insect repellant to be applied directly to clothing, or for small quantities of aerosol insecticide, such as fly and spider sprays, to be applied within or directly to offices or shop buildings
2. Submit Pest Management/Integrated Pest Management Checklist when chemicals or applications meet one or more of the following:
  - a. Chemicals categorized by USEPA for restricted use.
  - b. Chemicals applied to or that can reasonably be expected to contact water; except this requirement does not apply to Rodeo or copper sulfate used for control of noxious weeds.
  - c. Chemicals expected to endanger threatened animal or plant species.
    - 1) Form available from:
      - a) <https://teamssp.bor.doi.net/printanddup/forms/7Forms/7-2615.pdf>
      - b) Bureau of Reclamation, Attn: 86-68200, P.O. Box 25007, Denver, CO 80225-0007.

- d. Complete label as defined by Federal Insecticide Fungicide Rodenticide Act (FIFRA) and Federal Facilities of 1947, as amended in 1972 by the Federal Environmental Pesticide Control Act and Pesticide Registration Improvement Act of 2003, containing the following:
  - 1) Name, brand, or trademark product sold under..
  - 2) Name and address of the producer or registrant.
  - 3) Net contents.
  - 4) Producing establishment's number.
  - 5) Ingredient statement.
  - 6) Warning or precautionary statements.
  - 7) Directions for use.
  - 8) Use classification.
- e. Safety Data Sheet (SDS).

#### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with labeling and SDS requirements when dealing with pesticides.
- B. Keep records of pesticide types and amounts purchased, delivered, stored, mixed, and actually used, and disposal means of excess. Make records available for review by COR upon request.

### **PART 2 PRODUCTS**

#### **2.01 PESTICIDES**

- A. Pesticides: Only those registered with EPA in compliance with Federal Environmental Pesticide Control Act of 1972 and Pesticide Registration Improvement Act of 2003, or State, Navajo Nation or local agencies.

### **PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 57 50**  
**TREE AND PLANT PROTECTION**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for other items of work, except as specified.
  2. Costs for repair or treatment of injured vegetation and replacement of trees or shrubs are Contractor's responsibility.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 57 50-1, Protection Plan:
1. Description of protective barriers or other methods used to protect vegetation from damage or injury caused by construction operations.

**PART 2 PRODUCTS**

**2.01 REPLACEMENT TREES AND SHRUBS**

- A. Species: Same as removed tree or shrub or other species approved by COR.
- B. Size: Same size as removed tree or shrub, or maximum practicable size that can be planted and sustained in the particular environment as approved by COR.

**PART 3 EXECUTION**

**3.01 PRESERVATION AND PROTECTION**

- A. Preserve natural landscape and preserve and protect existing vegetation not required or otherwise authorized to be removed:
1. Submit requests to remove vegetation not specifically required to be removed to COR.
- B. Conduct operations to prevent unnecessary destruction, scarring, or defacing of natural surroundings in vicinity of work.

- C. Move crews and equipment within rights-of-way and over routes provided for access to the work in a manner to prevent damage to grazing land, crops or property.
- D. Protect vegetation from damage or injury caused by construction operations, personnel or equipment by use of protective barriers or other methods approved by COR.
- E. Minimize, to greatest extent practicable, clearings and cuts through vegetation. Irregularly shape authorized clearings and cuts to soften undesirable aesthetic impacts.
- F. Do not use trees for anchorages except in emergency cases or as approved by COR:
  - 1. For such use, wrap trunk with a sufficient thickness of approved protective material before rope, cable or wire is placed.
  - 2. Submit requests to use trees for anchorage, except for emergencies. Include description of protective material.
- G. Use safety ropes where tree climbing is necessary; do not use climbing spurs.

### **3.02 REPAIR, TREATMENT, OR REPLACEMENT**

- A. Contractor is responsible for injuries to vegetation caused by Contractor operations, personnel or equipment.
- B. Employ the services of an experienced arborist or licensed tree surgeon to direct repair, treatment, and replacement of injured vegetation. Submit qualifications of experienced arborist or licensed tree surgeon to COR prior to employment.
- C. Repair or treat injured vegetation without delay and as recommended by and under direction of an experienced arborist or licensed tree surgeon.
- D. Removed and dispose of trees or shrubs not required or otherwise authorized to be removed that, in the opinion of COR, are injured beyond saving.
- E. Replace removed tree or shrub with tree or shrub approved by COR:
  - 1. For a period of 1-year, guy as required, water, and maintain replacement trees and shrubs.
  - 2. Remove and replace any replacement tree or shrub that dies within the 1-year period, and maintain such replacements for a period of 1-year from date of replacement.

**END OF SECTION**

**SECTION 01 57 60**  
**PROTECTED SPECIES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 PROJECT CONDITIONS**

A. Certain native plant and animal species in the State of New Mexico are protected under Federal, State and Tribal laws. Government has ascertained that endangered Migratory Birds and Mesa Verde Cactus may exist in areas to be disturbed by construction activities.

B. This project is designed to comply with the Final Biological Opinion for the Navajo-Gallup Water Supply Project as issued by U.S. Fish and Wildlife Service on February 26, 2009.

C. Migratory Birds:

1. May occur in area between March 15<sup>th</sup> and August 15<sup>th</sup>:
  - a. Government will survey vegetated areas to be disturbed for endangered migratory birds. Evaluation shall be performed no more than 5 days before an area is to be disturbed.
  - b. Notify COR 10-days before disturbing an area.
  - c. Do not disturb a nesting pair of endangered migratory birds with eggs:
    - 1) Avoid birds as directed by COR.

D. Mesa Verde Cactus:

1. If Mesa Verde Cactus is found in construction area, Government will monitor work in these areas:
  - a. Contractor shall coordinate work in these areas with COR.

E. Insert this section in subcontracts which involve performance of work in areas with COR.

F. In accordance with State Law, Government may arrange for removal of protected species, and Contractor shall cooperate with those performing such removal. If these species are not removed, cooperate with and abide by protection plans developed by appropriate Federal, State and Tribal entities to avoid damage to or disturbance of protected species.

**1.03 REPLACEMENT PLANTS**

- A. Protected plant species shall not be removed or damaged by Contractor.
1. If inadvertent effects occur to protected species during construction:
    - a. Notify Government:
      - 1) Verbal: Within 2-hours.
      - 2) Written: Within 24-hours.
    - b. Cease work in affected work area until consultation commitments are completed.
  2. Government, in consultation with Bureau of Indian Affairs (BIA) and State of New Mexico, will manage required removal/replacement planting in accordance with consultation commitments.
  3. Replacement numbers/ratio in accordance with consultation commitments.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 57 90**  
**PRESERVATION OF HISTORICAL AND ARCHEOLOGICAL DATA**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Except as provided for an equitable adjustment, include in prices offered in the Price Schedules for other items of work.

**1.02 DEFINITIONS**

- A. Cultural resources: Includes prehistoric, historic, architectural, and traditional cultural properties. These include, but are not limited to, human skeletal remains, archaeological artifacts, records, and material remains related to such property.
- B. Cultural items: Native American cultural items (i.e., funerary objects, sacred objects, objects of cultural patrimony, or human remains) for which protection is prescribed under the Native American Graves Protection and Repatriation Act (NAGPRA) - Public Law 101-601; 104 Stat. 3042, Section 3(d); and 43 CFR Part 10.4.
- C. Human remains: Physical remains of the body of a person.
- D. Funerary objects: Native American items that, as part of the death rite or ceremony of a culture, are reasonably believed to have been placed intentionally at the time of death or later with or near individual human remains.
- E. Native American: Of, or relating to, a tribe, people, or culture that is indigenous to the United States.
- F. Sacred Objects: Native American items that are specific ceremonial objects needed by traditional Native American religious leaders for the practice of traditional Native American religions by their present-day adherents. These items are specifically limited to objects that were devoted to a traditional Native American religious ceremony or ritual and which have religious significance or function in continued observance or renewal of such ceremony.
- G. Objects of cultural patrimony: Native American items having ongoing historical, traditional, or cultural importance central to the Indian tribe itself, rather than property owned by an individual tribal member. These objects are of such central importance that they may not be alienated, appropriated, or conveyed by any individual tribal member.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.

- B. RSN 01 57 90-1, Alternate Use Area or Borrow Area:
  - 1. When use area or borrow area other than those approved is to be used, submit map showing location of unapproved use or borrow areas, for approval.

#### **1.04 PROJECT CONDITIONS**

- A. Project site has been surveyed for construction within ROW by agencies having jurisdiction. Navajo Nation Historical Preservation Department (NNHPD), State Historical Preservation Office (SHPO) and Bureau of Indian Affairs (BIA).
- B. Government will retain an Archeologist to monitor ground disturbing activity work within 50-foot, each side of known cultural sites:
  - 1. Coordinate work with COR and Government Archeologist.
- C. On-site Contractor personnel shall undergo cultural resource awareness training:
  - 1. Government will provide training. Training will take approximately 1-hour. Schedule for training will be mutually agreed upon.
  - 2. Inform on-site personnel of cultural resource requirements before initial groundbreaking takes place.
  - 3. On-site personnel added after completion of cultural awareness training shall be informed by their management of cultural resource requirements before being allowed to work in project area.
  - 4. Maintain training records.
- D. Federal legislation provides for protection, preservation, and collection of scientific, prehistorical, historical, and archeological data, including relics and specimens, which might otherwise be lost due to alteration of terrain as a result of any Federal construction project.
- E. Persons who, without permission, injure, destroy, excavate, appropriate, or remove historical or prehistorical artifact, object of antiquity, or archeological resource on public lands of the United States are subject to arrest and penalty of law.
- F. Comply with Federal, State and Tribal laws when operating on non-Federal and non-Indian lands.
- G. Attend weekly coordination meetings. Refer to Section 01 31 19 – Project Management and Coordination.
- H. Discovery of Resources:
  - 1. When Contractor or parties operating or associated with Contractor, in performance of this contract discover cultural resources on ROW:
    - a. Immediately cease work at that location.

- b. Verbally notify CO and COR within 2-hours, giving location and nature of findings.
  - c. Verbally notify Reclamation staff archaeologist within 2-hours.  
Telephone: 970-385-6500, Durango, Colorado.
  - d. Follow with written confirmation to CO within 12-hours.
- 2. Do not disturb or damage cultural resources uncovered during construction activities. Provide cooperation and assistance to preserve findings for removal or other disposition by CO.
  - 3. Do not resume work in area of discovery until receipt of written notice to proceed from CO.
- I. Where appropriate by reason of discovery, CO may order delays in time of performance or changes in work, or both. When such delays or changes are ordered, an equitable adjustment will be made in contract in accordance with applicable clauses of contract.
  - J. Mitigate cultural resources as directed by Government on lands outside of Permanent or Construction ROW, including private lands:
    - 1. Coordinate Government cultural resource identifications and inspections:
      - a. Obtain permission for Government access in arrangements for use of lands outside of ROW including private lands for use areas or borrow sources, access routes and areas of disturbance.
  - K. Insert this section in subcontracts which involve performance of work on jobsite terrain.
  - L. Obtain Government clearance before disturbing lands outside of ROW in accordance with Section 01 14 10 – Use of Site.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 EXCLUSION ZONE**

- A. Fence exclusion zones as directed by COR and in accordance with Section 01 56 32 – Temporary Safety Fence.

**END OF SECTION**

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**SECTION 01 60 00**  
**PRODUCT REQUIREMENTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. When the Price Schedules include a separate item for furnishing a material, include cost of furnishing, hauling, storing, and handling in the price offered in Price Schedules for item.
  2. When the Price Schedules do not include a separate item for furnishing a material, include cost of furnishing, hauling, storing, and handling in price offered in Price Schedules for work for which material is required.

**1.02 DEFINITIONS**

- A. Essential Characteristics: As used in these specifications, the term "essential characteristics" is synonymous with the term "salient characteristics."
- B. Salient Characteristics: Those qualities of an item that are essential to ensure that intended use of item can be satisfactorily realized.

**1.03 REFERENCE STANDARDS**

- A. American Society of Mechanical Engineers (ASME)
1. ASME B 1.1-03(2008) Unified Inch Screw Threads, (UN and UNR Thread Form)
  2. ASME B 1.20.1-13 Pipe Threads, General Purpose, Inch
- B. Bureau of Reclamation (Reclamation)
1. RSHS Reclamation Safety and Health Standards, including revisions posted at:  
[www.usbr.gov/ssle/safety/RSHS/rshs.html](http://www.usbr.gov/ssle/safety/RSHS/rshs.html)

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Transport and handle manufactured products in accordance with manufacturer's instructions.
- B. Store and protect manufactured products in accordance with manufacturer's instructions and RSHS. Obtain instructions from manufacturer before delivery of materials to jobsite. Maintain a copy of instructions at jobsite.

- C. Protect materials from adverse effects of moisture, sunlight, ultraviolet light or weather during storage at jobsite.
- D. Remove and replace damaged items with new items.
- E. Store curing compounds, sealants, adhesives, paints, coatings, sealers, joint compounds, grouts, and similar products at temperature and environmental conditions recommended by manufacturer.

## **1.05 MAINTENANCE**

- A. Extra Materials:
  - 1. Furnish additional maintenance materials specified as "extra materials" in specifications. Provide maintenance material identical to installed material and provide from same manufacturer's production lot as installed material.
  - 2. Package extra materials for storage and label with complete product identification on packaging.
  - 3. Deliver extra materials to Government as directed by COR within 150-miles of project.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Provide materials required for completion of work.
- B. Provide type and quality described in these specifications. Make diligent effort to procure specified materials from all available sources.
- C. Furnish new materials conforming to referenced standards unless otherwise specified.
- D. For materials not covered by these or referenced specifications, furnish materials of standard commercial quality.
- E. If materials to be used deviate from or are not covered by recognized specifications and standards, submit, for approval, justification for and exact nature of the deviation, and complete specifications for materials proposed for use.
- F. Make parts accurately to standard gauge where possible:
  - 1. Use unified screw threads conforming to ASME B1.1 or ASME B1.20.1 for threads, including but not limited to those of bolts, nuts, screws, taps, pipes, and pipefittings.
  - 2. For internal connections only, Contractor may deviate from ASME standards, provided a complete set of taps and dies are furnished as required to facilitate repair or replacement.

- G. Permanently mark fasteners with a symbol identifying manufacturer and with symbol(s) indicating grade, class, type, and other identifying marks in accordance with reference or applicable standard.

## **2.02 SUBSTITUTIONS**

- A. If materials required by these specifications become unavailable, because of Government priorities or other causes, substitute materials may be used.
- B. Obtain written approval to use substitute materials from CO. State in request for approval amount of adjustment, if any, to be made in favor of Government.
- C. Government's determination as to whether substitution will be permitted and as to what substitute materials may be used, shall be final and conclusive.
- D. If approved substitute materials are of less value to Government or involve less cost to Contractor than specified material, a contract adjustment will be made in favor of Government. Where amount involved or importance of substitution warrants, a deductive modification to contract will be issued.
- E. No payments in excess of prices offered in the Price Schedules will be made because of substitution of one material for another or because of use of one alternate material in place of another.

## **2.03 WORKMANSHIP**

- A. Accurately manufacture and fabricate materials in accordance with best modern practice and requirements of these specifications, notwithstanding minor errors or omissions therein.
- B. Use liberal factors of safety and adequate shock-absorbing features in designs, especially for parts subjected to variable stress or shock, including alternating or vibrating stress or shock.
- C. Include provisions which prevent components from loosening for shock-absorbing features and parts subject to vibration.

## **2.04 GOVERNMENT CONTRACT SOURCE QUALITY ASSURANCE**

- A. Materials will be subject to inspection in accordance with clause at FAR 52.246-12 "Inspection of Construction" at following locations, as determined by CO at:
  - 1. Place of production or manufacture.
  - 2. Shipping point.
  - 3. Jobsite.
- B. To allow sufficient time to provide for inspection, submit at time of issuance, copies of purchase orders, including drawings and other pertinent information, covering material

on which inspection will be made as advised by CO, or submit other evidence if such purchase orders are issued verbally or by letter.

- C. Inspection of materials at locations specified above or waiving of inspection shall not be construed as being conclusive as to whether materials and equipment conform to contract requirements under the clause at FAR 52.246-12 "Inspection of Construction" nor shall Contractor be relieved thereby of responsibility for furnishing materials meeting requirements of these specifications.
- D. Acceptance of materials will be made only at jobsite.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install products in accordance with manufacturer's recommendations unless otherwise specified.

#### **3.02 GOVERNMENT CONTRACT FIELD QUALITY ASSURANCE**

- A. Final inspection and acceptance of materials will be made only at jobsite after installation and testing.

**END OF SECTION**

**SECTION 01 71 20**  
**SURVEYING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 DEFINITIONS**

A. GPS: Global Positioning System.

B. GNSS: Global Navigation Satellite Systems.

C. TPS: Terrestrial Positioning Systems such as total stations and automatic levels.

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 01 71 20-1, Surveying Plan:

1. Describe work layout and survey methods.
2. Surveying schedule.
3. Example of field records format on electronic data collection devices.

C. RSN 01 71 20-2, Resume:

1. Proof of Registration as a licensed surveyor or engineer in New Mexico.
2. Construction surveyor.

D. RSN 01 71 20-3, Accuracy Check Results:

1. Accuracy check of Government-established primary control.

E. RSN 01 71 20-4, Completed and Reduced Survey Notes:

1. Copy of completed and reduced survey notes (electronic or paper) for a survey or portion of survey. Include ASCII coordinate files.
2. Field records on electronic data collection devices: Include electronic files and paper copies of notes.

F. RSN 01 71 20-5, Original Field Survey Books.

- G. RSN 01 71 20-6, Quantity Survey Notes and Computations:
1. Itemized statement for work covered by notes and computations.
    - a. Electronic files that support calculations (i.e. dwg, ASCII, dets, landXML).
  2. When progress payment invoice includes unit priced pay items that surveys required for computing quantities, this submittal is part of documentation required for a proper invoice for progress payments in accordance paragraph (a)(2)(xi) of the clause at FAR 52.232-27 – Prompt Payment for Construction Contracts.
- H. RSN 01 71 20-7, Workday's Survey Notes:
1. Copies when requested by Government.

#### **1.04 PRIMARY CONTROL**

- A. Government will establish primary control to be used for establishing work lines and grades.
- B. Primary control consists of bench marks and horizontal control points in work vicinity.
- C. Government will provide complete listing and identification of primary control within 15-days after issuance of Notice to Proceed. See 51 00 00 – Information Available to Offerors.
- D. Check and verify primary control and resolve discrepancies with Government before beginning work.
- E. Preserve and maintain primary control points until otherwise authorized. Government may reestablish damaged or destroyed primary control points and back charge reestablishment cost to Contractor.

#### **1.05 QUALIFICATIONS**

- A. Responsible Surveyor:
  1. Professional Land Surveyor or Professional Engineer.
  2. Registered in New Mexico.
  3. When GPS/GNSS is utilized, shall have working knowledge of geodesy, GNSS/GPS capabilities.
- B. Certified Construction Surveyors:
  1. Under supervision and direction of Professional Land Surveyor or Professional Engineer.
  2. Minimum 2-years' experience in charge of construction surveys for construction projects similar in nature to that required by this contract.

3. In charge of construction surveys for at least 2 projects similar in nature to that required by this contract.

## **PART 2 PRODUCTS**

### **2.01 SURVEYING MATERIALS AND EQUIPMENT**

- A. Provide materials required for surveying work, including, but not limited to, stakes, spikes, steel pins, templates, platforms, and tools:
  1. Except as required to be incorporated in work or left in place, surveying materials remain property of Contractor.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Construction surveyor shall be on site during construction activities to provide control of work.
- B. Cultural Resources:
  1. Obtain COR approval before entering site with a vehicle.
  2. Refer to Section 01 57 90 – Preservation of Historical and Archeological Data if cultural resources are encountered.

### **3.02 LAYOUT OF WORK SURVEYS**

- A. Establish lines and grades for work layout from Government-established primary control points.
- B. Establish measurements required for work execution to specified tolerances.
- C. Provide stakes, markers, and other survey controls necessary to control, check, and guide construction. Place and mark controls so COR can monitor progress without the use of survey equipment.

### **3.03 QUANTITY SURVEYS**

- A. Perform surveys and computations to determine quantities of work performed or placed during each progress payment period.
- B. Perform surveys necessary for Government to determine final quantities of work in place. Final payment quantities will be based on Government's original terrain data and submitted survey notes and computations.

- C. Perform quantity surveys in presence of authorized Government representative, unless specifically waived. Notify Government at least 24-hours before performing a quantity survey.

### **3.04 SURVEY REQUIREMENTS**

- A. Alignment and ROW Staking: Each 50-feet on tangent and each 25-feet on curves.
- B. Slope Staking: Each 50-feet on tangent and each 25-feet on curves, stake every 10-feet in elevation on slopes.
- C. Structures: Stake out of structures and checkouts before and during construction.
- D. Roads: Blue tops each 50-feet on tangent and each 25-feet on curves.
- E. Cross-sections: Original, final, and intermediate as required, for structure sites and other locations as necessary for quantity surveys. Survey borrow areas before and after removal of materials, but before final shaping.
- F. As-builts: As required for structures and other features of work.
- G. A licensed surveyor shall survey and stake ROW boundaries.

### **3.05 ACCURACY**

- A. Degree of Accuracy:
  - 1. Alignment of Tangents and Curves: Within 0.1-foot.
  - 2. Structure Points: Set within 0.01-foot, except where installation or operation considerations require tighter tolerances.
  - 3. Blue Tops: Set within 0.1-foot.
  - 4. Cross-Section Points: Locate within 0.1-foot, horizontally and vertically.
  - 5. Vertical Control Surveys: Close within 0.05-foot times the square root of circuit length in miles.

### **3.06 FIELD RECORDS**

- A. Record field notes, computations, and other surveying data on electronic data collection devices or in fieldbooks. Field records shall be complete and accurate record of survey.
- B. Record survey data in accordance with recognized professional surveying standards.
  - 1. Notes or data not in accordance with standard formats will be rejected.
  - 2. Illegible notes or data or erasures on any page of a fieldbook will be sufficient cause for rejection of part or all of fieldbook.
  - 3. Corrections by ruling or lining out errors will be permitted.

4. Copied notes or data will not be permitted.
  5. Rejection of part or all of a fieldbook may necessitate resurveying.
- C. Data and notes may be collected on electronic data collection devices with prior approval of COR.
1. Electronic files of notes: In approved format.
  2. Include electronic files and paper copies of notes in submittals.

**END OF SECTION**

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**SECTION 01 74 00**  
**CLEANING AND WASTE MANAGEMENT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for other items of work except as specified.
  2. Cost of environmental site assessments are Contractor's responsibility.

**1.02 DEFINITIONS**

- A. Hazardous waste: Defined as hazardous by 40 CFR 261.3; or by other Federal, State, Tribal or local laws or regulations.

**1.03 REFERENCE STANDARDS**

- A. Bureau of Reclamation (Reclamation)
1. RSHS Reclamation Safety and Health Standards, including revisions posted at:  
[www.usbr.gov/ssle/safety/RSHS/rshs.html](http://www.usbr.gov/ssle/safety/RSHS/rshs.html)
- B. Code of Federal Regulations (CFR)
1. 40 CFR 261.3 Definition of Hazardous Waste
  2. 49 CFR 171-179 Transportation - Hazardous Waste Regulations

**1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 74 00-1, Waste Production and Disposal Plan:
1. For each type of waste, list estimated quantity and planned disposal location.
- C. RSN 01 74 00-2, Waste Production and Disposal Records:
1. For each type of waste, list quantity and disposal location.
  2. Certifications waste was properly disposed.
  3. Recycled waste materials verification.
  4. Hazardous wastes manifests.
- D. RSN 01 74 00-3, Environmental Consultant Resume:
1. Describe experience on similar project.

E. RSN 01 74 00-4, Environmental Site Assessment.

### **1.05 QUALIFICATIONS**

A. Environmental consultant: Minimum 2-years' experience in conducting environmental site assessments for similar construction.

### **1.06 REGULATORY REQUIREMENTS**

A. Comply with Federal, State, Navajo Nation, and local laws and regulations.

B. Comply with RSHS.

C. Conform to most stringent requirement in cases of conflict between specifications, regulatory requirements, and RSHS.

D. Comply with local regulations for pre-suppression, suppression, and prevention of fires when burning wastes.

### **1.07 PROJECT CONDITIONS**

A. Report waste materials discovered at jobsite to COR.

1. Cease work in areas where waste may be hazardous until waste materials are investigated by Government.
2. Have Environmental Consultant investigate waste materials and make recommendations for continuing work. Government will review and approve of investigation and recommendations.
3. If waste is hazardous, CO may order delays in time of performance or changes in work, or both.
4. If such delays or changes are ordered, an equitable adjustment will be made in the contract in accordance with applicable clauses of the contract.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 PROGRESS CLEANING**

A. Keep work and storage areas free from accumulations of waste materials and rubbish.

### **3.02 FINAL CLEANUP**

A. Remove temporary plant facilities, buildings, concrete footings and slabs, rubbish, unused materials, concrete forms, and other similar materials which are not part of permanent work.

- B. Leave structures "broom clean".

### **3.03 DISPOSAL**

- A. Nonhazardous waste materials:
  - 1. Dispose by removal from jobsite.
  - 2. Dispose of nonhazardous waste materials that are not reused or recycled at appropriately permitted disposal facilities.
- B. Hazardous Waste Disposal:
  - 1. Dispose by removal from jobsite.
  - 2. Recycle hazardous waste whenever possible.
  - 3. Dispose of hazardous waste materials that are not recycled at appropriately permitted treatment or disposal facilities.
  - 4. Transport hazardous waste in accordance with 49 CFR 171-179.
- C. Certification: Certify that wastes are disposed of in accordance with Federal, State, Tribal and local regulations.

### **3.04 SITE ASSESSMENT**

- A. Upon completion of work, perform site assessment at following areas for work done under these specifications:
  - 1. Hazardous waste accumulation areas.
  - 2. Petroleum dispensing and storage areas where aggregate storage of petroleum at jobsite was over 110-gallons.
  - 3. Hazardous material storage areas.
  - 4. Identified clean-up sites.
- B. Employ qualified environmental consultant to perform assessments.
- C. Demonstrate and document by appropriate analytical sampling that site contamination is less than State action cleanup levels. Submit written report with sampling locations, findings, manifests, photos and other pertinent information.

### **3.05 RECORDS**

- A. Keep records of types and amounts of waste materials produced.
- B. Keep records of waste material disposal.

**END OF SECTION**

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**SECTION 01 78 30**  
**PROJECT RECORD DOCUMENTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. As-built and Final Drawings:
  - 1. Measurement: Number of As-built and Final Drawings provided.
  - 2. Payment: Unit price stated in the Price Schedules.
- B. Operations and Maintenance (O&M) Manuals:
  - 1. Measurement: Number of O&M Manuals Provided.
  - 2. Payment: Unit price stated in the Price Schedules.

**1.02 DEFINITIONS**

- A. As-built Drawings (Also known as “Red-line” Drawings):
  - 1. Set of full size, hard-copy drawings, that contain both Government informational drawings supplied with the Specifications and Contractor produced drawings that have been submitted for approval.
- B. Final Drawings:
  - 1. Complete electronic set of drawings produced by Contractor for each Pumping Plants updated to reflect all changes made in the field through installation and commissioning of each plant.
- C. Operations and Maintenance (O&M) Manuals:
  - 1. Final documentation package delivered for each Pumping Plant containing all information necessary for Government to operate and maintain equipment in a safe, effective, and efficient manner. Transmitted both in bound hard-copy and electronic form. Divided into volumes with a main volume common to the each Pumping Plant and unit volumes containing documentation specific to each system within each Pumping Plant.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 01 78 30-1, As-built and Final Drawings:
  - 1. Certified marked sets. As-built drawings that have been certified by Contractor as being up to date and accurate as shown in the description of work.

2. Submit to COR for approval and release following commission of each system and prior to training and/or Government possession.
- C. RSN 01 78 30-2, Final Drawings:
1. Submit to COR for Government approval no later than 14 calendar days following approval of RSN 01 78 30-1, As-built drawings.
  2. Updated with all changes as marked on As-built drawings to reflect approval comments.
- D. RSN 01 78 30-3, O&M Manuals:
1. Provide two sets of O&M Manuals. One for Pumping Plant No. 4 and one for Pumping Plant No. 7:
    - a. Provide both electronic copy and hard copy. Number of hard copies as indicated in Section 01 33 00 – Submittals.
  2. Submit O&M Manual within 60-days following commissioning of each Pumping Plan.

#### **1.04 AS-BUILT DRAWINGS**

- A. Maintain 2 sets of full-size prints of contract drawings marked to show accurate and complete records of As-built conditions. Keep drawings at jobsite and mark as work progresses:
1. Mark and dimension to show variations between actual construction and that indicated or specified in contract documents:
    - a. Include buried or concealed construction and utilities.
    - b. Include existing items, topographic features, and utility lines revealed during construction which differ from those shown on contract drawings.
  2. Mark to define construction actually provided where choice of materials or methods is permitted in specifications, or where variations in scope or character of work from that of the original contract are authorized.
- B. Use standard drafting practice to represent changes and include supplementary notes, legends, and details necessary to clearly portray As-built construction.
- C. Mark As-built drawings in the following colors:
1. Red - Additions to original drawings.
  2. Green - Deletions to original drawings.
  3. Blue - Notations necessary for explanation of As-built markings.
- D. Allow Government to review drawings during weekly construction meetings and be available at all other times.

- E. Upon completion of work and prior to training and/or Government possession, submit to COR for review and acceptance:
1. One set will be maintain by Government:
    - a. For maintenance of changes to Government provided information drawings.
    - b. For verification of Final Drawings.
  2. Sign marked prints as certified correct:
    - a. Sign and date each drawing as certified correct. Do not include or certify Information Only drawings.
    - b. If no revisions were necessary to illustrate As-built conditions, mark drawing with “No Changes.”
    - c. Provide As-built drawings as outlined in Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.

## **1.05 O&M MANUALS**

- A. O&M Manuals shall include information required by Government personnel to operate, maintain, and troubleshoot equipment including at a minimum the following:
1. Index sheet at front of each manual which provides page or index tab number information for each devise of item of equipment in manual.
  2. Bill of Materials.
  3. Manufacturer’s product data sheets and operation and maintenance procedures.
  4. Spare part inventory and list of any additional recommended spares that were not required by these specifications.
  5. System maintenance schedule and procedures including instructions on dismantling, replacing, installing, calibrating, configuring, and troubleshooting provided equipment.
  6. Description of Pumping Plant operation with operating procedures.
  7. Onsite commissioning test procedures.
  8. SCADA and Communications software connection procedures.
  9. Performance Shop test reports.
  10. Wiring and cable test reports.
  11. Operational field test reports.
  12. Final Drawings.
- B. Any Contractor delay resulting from failure to provide timely and acceptable documents will not constitute acceptance of any time extension to the contract.

## **1.06 FINAL DRAWINGS**

- A. Update all drawings and diagrams either generated by Contractor or impacted by Contractor performed work with all modifications made during design and construction process, including all modifications made during testing and commissioning. Include all As-built drawing modifications.
- B. Drawings shall represent final installed condition of facility at completion turnover of system to Government.
- C. Drawings supplied as Final Drawings shall meet requirements of Final Drawings included in Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- D. Computer drafted drawings provided in electronic file format, compatible with AutoCAD, 2018 or later.
- E. Upon completion, sign prints as certified correct:
  - 1. Sign and date each drawing as certified correct.
  - 2. If no revisions were necessary, mark drawing with “No Changes.”

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 CONSTRUCTION DOCUMENTATION**

- A. Provide and maintain at least 2 copies of As-built Drawings and manufacturer’s installation instructions at jobsite upon equipment shipment:
  - 1. Drawings shall be in ‘As-built condition at time of equipment shipment and shall reflect Government approval comments.
- B. Mark drawings with changes and revisions made during installation and checkout of equipment following As-built marking procedures:
  - 1. Mark and dimension to show variations between actual construction and that indicated or specified in contract documents.
  - 2. Mark to define construction actually provided:
    - a. Where choice of materials or methods is permitted in specifications.
    - b. Where variations in scope or character of methods is permitted in specifications.
    - c. Where variations in scope or character of work from that of original contract are authorized.

- C. Upon completion of work:
1. Sign marked prints as certified correct.
  2. Submit to COR for approval within 14-days following commissioning test completion:
    - a. One set to be retained by COR.
    - b. One set to be used in preparation of Final Drawings for each unit:
      - 1) Due no later than 14 calendar days following approval of As-built Drawings.

**END OF SECTION**

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**SECTION 01 80 15**  
**COMMISSIONING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Commissioning:
1. Payment: Lump sum price offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

- A. International Society of Automation
1. ISA 62381-2012 Automation Systems in the Process Industry – Factory Acceptance Test (FAT), Site Acceptance Test (SAT), and Site Integration Test (SIT)
  2. ISA 62382-2012 Automation Systems in the Process Industry – Electrical and Instrumentation Loop Check
- B. National Fire Protection Association, Inc. (NFPA)
1. NFPA 70-2017 National Electrical Code (NEC)

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 01 80 15-1, Qualifications
- C. RSN 01 80 15-2, Test Plan
- D. RSN 01 80 15-3, Testing Procedures
- E. RSN 01 80 15-4, Test Reports
- F. RSN 01 80 15-5, Discrepancy List
- G. RSN 01 80 15-6, Post Testing and Commissioning Documentation

## **1.04 COMMISSIONING**

- A. Commissioning:
  - 1. Consists of flow testing, gate control testing, and SCADA system integration testing, verifying component feedback, and verifying operator and control interface with components.
  - 2. Systematic process of ensuring that all systems perform interactively according to design intent and Government's operational needs.
  - 3. Encompasses and coordinates separate functions of system documentation, equipment startup, control system calibration, testing and balancing, and performance testing.

## **1.05 QUALIFICATIONS**

- A. Entities either preparing testing or commissioning documentation or performing testing or commissioning activities shall have performed services for at least three installations of similar type in the past 5-years.

## **1.06 SCOPE**

- A. Components supplied, installed, or modified for this Project.
- B. Demonstrate correct operation of the system including, but not limited to the following:
  - 1. SCADA System.
  - 2. Pumping units.
  - 3. Valves.
  - 4. Tanks and associated systems.
  - 5. Air chamber systems.
  - 6. Water systems
  - 7. Instrumentation.
  - 8. Engine Generators.
  - 9. Electrical Distribution System.
  - 10. Smoke Control System.
  - 11. Chlorine Disinfection Systems.
  - 12. All control and automation functions and operator interfaces used to operate and monitor facility systems with flowing water and without flowing water.
- C. Demonstrate hardware and software functionality, performance, and stability.
- D. Includes all testing and commissioning activities either required or recommended in accordance with ISA 62381, and ISA 62382 and manufacturer's documentation.

- E. Includes:
  - 1. Any field verification of any component rating curves or operational setpoints and any required tuning or adjustment of control loops or settings.
  - 2. Provide independent verification of flowmeter data.
- F. Perform and support flow testing for facility to facility operation under rated flow conditions.
- G. Implement software, settings or graphic display modifications requested by Government as a result of testing or commissioning activities.

## **1.07 COMMISSIONING PROCESS**

- A. Phases of Testing and Commissioning Work:
  - 1. Construction Testing:
    - a. Perform in accordance with requirements in these Specifications.
    - b. Includes inspections and tests at component and device level.
  - 2. Preoperational Test Phase:
    - a. Inspections of complete installation.
    - b. Perform site acceptance testing and site integration testing in accordance with ISA 62381.
    - c. Perform loop checks per ISA 62382, perform verification for each loop and each input or output.
  - 3. Commissioning (also Operational Test Phase):
    - a. Includes cold commissioning and hot commissioning activities.
    - b. Technical personnel shall be available onsite to provide consultation with Government personnel if any questions or problems arise during the test.
  - 4. Reliability Test Run:
    - a. Provide minimum 30-day facility reliability test run. At completion of other commissioning and startup activities:
      - 1) Coordinate with COR for scheduling reliability run test. Timeframe should be chosen to allow water to be continuously run through the installation.
      - 2) If a malfunction occurs during reliability test run restart test run.
      - 3) During test Government personnel will perform normal system control actions using Contractor supplied equipment.

## 1.08 COMMISSIONING PROCESS DOCUMENTATION

### A. General:

1. Documentation prepared by Contractor shall represent a testing program in accordance with guidelines in ISA 62381, and ISA 62382.
2. Inspection and test documentation shall include the following:
  - a. Name and signature of person performing test.
  - b. Date at which test was performed.
  - c. Identification of component, equipment, or system tested.
  - d. Identification of tests performed.
  - e. Summary of results of test or inspection activity, including positive identification for each activity of whether system or component passed or failed.
  - f. Any data or readings taken during test to verify component, equipment, or system acceptance.

### B. Contractor shall generate the following documentation:

1. Test Plan:
  - a. Specific detailed test plan of testing and commissioning activities planned for site acceptance and commissioning testing. Includes following:
    - 1) Construction testing to provide component level acceptance testing verification of components supplied, installed, or modified by Contractor.
    - 2) Preoperational and commissioning testing.
2. Test Procedures.
  - a. Detailed procedures for all planned testing and commissioning activities.
  - b. If pressurization of any system is required in testing procedures or specifications include how system will be pressurized, how pressurized water or air will be discharged and where water or air source will be obtained from. Any water system that is potable will be tested with potable water.
  - c. If references are used in testing procedures, include a copy of reference in testing procedures.
3. Testing and Commissioning:
  - a. Turnover Books:
    - 1) Contractor assembled and maintained at jobsite.
    - 2) Contains records of all testing and commissioning activities performed, including specific test data and reports.

- 3) Updated as each test or commissioning activity is performed.
  - 4) Available for COR review immediately upon request.
  - 5) Maintain turnover books onsite in secure location. Contractor shall not remove turnover book from site without specific written approval from COR.
- b. Test Reports:
- 1) Typed, 8 1/2- by 11-inch sheets.
  - 2) Certified, signed, dated, and attested to having passed requirements and tests.
  - 3) Provide data summary and necessary graphs and plots of tests performed.
  - 4) Available for COR review upon request.
  - 5) Use in preparing final drawings.
- c. Issues and Resolution Log.
- d. Field Check Prints: Marked field check prints with drawing modifications in accordance with Section 01 78 30 – Project Record Documents and Section 01 33 26 – Electrical Drawings and Data.
4. Discrepancy List:
- a. Contractor shall maintain a discrepancy list documenting discrepancies found during inspection, testing and commissioning activities.
5. Post Testing and Commissioning Activities:
- a. Provide Turnover books to Government, including copies of all test reports and documentation of all commissioning activities performed.

## **1.09 COORDINATION**

- A. Commissioning process requires active participation of design team, including designers, installation personnel, Manufacturers' Representatives, and other specific subcontractors, as deemed appropriate.
- B. Government will witness final functional performance commissioning process.
- C. Government reserves the right to witness any inspection, testing, or commissioning activities. Contractor shall inform COR in writing of scheduled activities a minimum of 14-days prior to performing the activity to allow Government the opportunity to witness. Contractor shall notify COR in writing a minimum of 60-days prior to any activities intended to move water in the installation.
- D. Government reserves the right to perform additional equipment testing on site with cooperation of Contractor to verify operability of the equipment.

- E. Contractor shall complete each phase of testing and commissioning work and request written confirmation of completion prior to continuing on to the next phase.
- F. Do not schedule testing until procedures are approved.
- G. Government shall determine final acceptance.

#### **1.10 EQUIPMENT SPECIFIC TESTING REQUIREMENTS**

##### **A. General:**

1. These requirements are in addition to those listed elsewhere in these Specifications and Contractor developed testing and commissioning documentation.

##### **B. SCADA and Control Systems:**

1. Demonstrate operation of all graphic displays and operator interfaces to graphic displays and HMIs.
2. Verify each system and component interlock. Insure that interlocks intended to prevent or trigger automatic operation act as intended. Where simulation of feedback signal is required to verify system interlock simulation shall be performed at the device unless device is inaccessible. Where possible device feedback shall be provided by operating or forcing feedback from the device, as long as it does not damage the device or present a safety hazard.
3. Contractor to perform adjustment and tuning of control loops, logic, settings and HMIs, and graphic displays.
4. Simulate equipment failures.
5. Verify logic and operation of the system.

##### **C. Communications Links:**

1. Verify all communication links between devices, including any communications links to pre-existing facility components.

##### **D. Information Technology and Cyber Security Related Testing:**

1. Perform capture of netflow data between components for network and protocol analysis at time of system commissioning.
2. Verify account based access control.
3. Validate network architecture including port address lists and device address lists.
4. Validate and document communication restrictions, filtering and monitoring rules through firewalls and other network components.
5. Perform additional Contractor and manufacturer recommended testing.
6. Government reserves the right to perform additional cyber security related testing and verification of the system with cooperation from Contractor.

- E. Flow Testing:
1. Includes flow testing for each pumping plant:
    - a. Includes operation of all pumps and valves associated with that pumping plant in each control mode available. Verify operation of pumping plant in both manual and automatic control modes. Verify proper operation of components and document any leakage or vibrations.
    - b. Inspection of pumping plant components to verify condition of those components.
    - c. Facility flow testing shall demonstrate ability of facility to operate within its designed operating range. COR will provide general guidelines for which operating points to test and time interval to test each while Contractor shall provide specific test procedures.
  2. Government reserves the right to perform additional testing and verification of the system with cooperation from Contractor.
  3. Technical personnel shall be available onsite to provide support during test.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Coordinate work activities in accordance with 01 31 19 – Project Management and Coordination.
- B. Provide instrumentation, test equipment, and personnel necessary for performing tests.

**END OF SECTION**

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**SECTION 03 11 10**  
**CONCRETE FORMING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

Include cost of furnishing and constructing forms in applicable prices offered in the Price Schedules for concrete items for which forms are required.

**1.02 REFERENCE STANDARDS**

A. American Concrete Institute (ACI)

1. ACI 318-14 Building Code Requirements for Structural Concrete and Commentary

B. APA - The Engineered Wood Association (APA)

1. APA PS 1-09 Structural Plywood

C. Bureau of Reclamation (Reclamation)

1. RSHS Reclamation Safety and Health Standards, including revisions posted at:  
[www.usbr.gov/ssle/safety/RSHS/rshs.html](http://www.usbr.gov/ssle/safety/RSHS/rshs.html)

D. Western Wood Products Association (WWPA)

1. WWPA WLGR-17 Western Lumber Grading Rules

**1.03 DESIGN**

A. Design formwork in accordance with RSHS.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 FORM MATERIALS**

A. Sheathing or Lining: Conform to Table 03 11 10A - Form Sheathing or Lining Materials, or provide other materials which will produce equivalent results.

Table 03 11 10A - Form Sheathing or Lining Materials

Finish	Wood sheathing or lining	Steel sheathing or lining
F1	Any grade common board or plywood	Steel sheathing permitted Steel lining permitted
F2	No. 2 common or better, shiplap, or plywood	Steel sheathing permitted Steel lining permitted if approved
F3	Plane surfaces: Plywood.  Warped surfaces: Plywood, or lumber which is free from knots and other imperfections and which can be cut and bent accurately without splinters or splitting.  Severe curvature: May be lined with continuously supported flexible material such as masonite or thin plywood. Use of material is subject to COR approval.	Steel sheathing permitted Steel lining not permitted.
Textured Surface	Use form liner specified for textured surface	Steel sheathing not permitted Steel lining not permitted

- B. Steel sheathing is steel sheets not supported by wood backing. Steel lining is thin sheets supported by wood backing.
- C. Wood Sheathing or Lining: Softwood or plywood of such kind and quality and treated or coated so that deterioration or discoloration of formed concrete surfaces due to chemical action, contamination, or uneven absorption of water from concrete is prevented.
- D. Plywood: APA PS 1, Exterior, Grade B-B Concrete Form, Class I, mill oiled and edge sealed.

- E. Softwood Lumber:
  - 1. Meet requirements of WWPA WLGR for dressed lumber or worked lumber of specified grade.
  - 2. Use common boards surfaced on both edges (S2E) in accordance with WWPA WLGR.
  - 3. Use 6- or-8 inch wide lumber for shiplap forms.
  - 4. Use same lumber width in forms for F2 finishes.

### **3.02 INSTALLATION**

- A. Construct forms to confine and shape concrete to required lines so that completed work meets specified structural deviations, surface tolerances, and finish requirements.
- B. Construct forms with sufficient strength to withstand pressure from placing and vibrating concrete. Maintain in proper position.
- C. Adjust formwork design and concrete placing rate to compensate for hydraulic pressures exerted on forms by concrete with high fluidity.
- D. Where form vibrators are to be used, construct forms with sufficient rigidity to effectively transmit energy from form vibrators to concrete without damaging formwork or altering form position.
- E. Seal surfaces and joints of forms to prevent absorption of water into forms or loss of mortar from concrete.
- F. Place chamfer strips in corners of forms and at tops of wall placements to bevel edges of permanently exposed concrete surfaces. Do not bevel interior angles of intersecting concrete surfaces and edges of construction joints except as indicated on drawings.
- G. Install sufficient plumb and string lines to monitor formwork positions before concrete placement. Monitor plumb and string lines during concrete placement and correct deficiencies in formwork.
- H. F2 Finish:
  - 1. Use 1 type of form sheathing or lining material for exposed F2 surfaces.
  - 2. Construct forms to produce a uniform and consistent texture and pattern on face of concrete. Metal patches on forms are not permitted.
  - 3. Place form sheathing or lining so that horizontal form marks are continuous across entire surface.
  - 4. For forms constructed of plywood form lining or shiplap panels, make vertical form marks continuous for entire height of surface.
  - 5. For forms constructed of shiplap which is not paneled, cut boards square, stagger vertical joints in boards, and place vertical joints at studs.

**I. F3 Finish:**

1. Construct forms to produce a uniform and consistent texture and pattern on face of concrete. Metal patches on forms are not permitted.
2. Align sheathing or lining horizontally and vertically and place to minimize joint marks on surfaces.
3. Place form sheathing or lining so that horizontal form marks are continuous across entire surface.
4. Make vertical form marks continuous for entire height of surface.
5. Fill and smooth finish voids at joints in plywood form lining or sheathing.
6. Do not construct forms continuously from lift to lift. Remove forms after concrete in a lift has hardened and reset forms for next lift.
7. Reset forms to overlap hardened concrete in previous lift by 1-inch, maximum.
8. Tighten forms snugly against hardened concrete so that forms will not spread and cause offsets or loss of mortar at construction joints when concrete placement is resumed. Provide additional bolts or form ties required to hold reset forms tight against hardened concrete.

**J. Form Ties and Anchors:**

1. Embed ties for holding forms.
2. Terminate ties not less than 2 diameters or twice minimum dimension of tie, whichever is greater, from formed surface of concrete, except where F1 finish is permitted.
3. Install ties so ends or end fasteners can be removed without causing spalling at face of concrete.
4. Provide form anchors as required to ensure that concrete surfaces will meet specified tolerances. Replace form anchors embedded in concrete which are loosened before placement of adjoining concrete with other supports firmly embedded in hardened concrete.

**K. Cleaning and Oiling Forms:**

1. Clean form surfaces of encrustations of mortar, grout, or other foreign material.
2. Coat form surfaces with a form oil which will prevent sticking and will not soften or stain concrete surfaces or cause concrete surface to become chalky or dust producing.

**3.03 REMOVAL**

- A. Remove forms within 24-hours after concrete has gained sufficient strength to prevent damage by form removal.

1. Nonsupporting forms such as sides of beams, walls, columns, and similar items: Remove after cumulatively curing at not less than 50 degrees F for 24-hours from time of concrete placement when:
    - a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
    - b. Curing protection is maintained.
  2. Forms for elevated structural slabs or beams:
    - a. Remove in accordance with ACI 318, Chapter 6.
    - b. Do not remove forms until concrete has reached compressive strength of at least 80 percent of specified 28-day compressive strength, as determined by test cylinders.
  3. Forms on upper sloping faces of concrete, such as forms on waterside of warped transitions: Remove as soon as concrete has attained sufficient stiffness to prevent sagging.
  4. Wood forms for wall openings: Loosen as soon as loosening can be accomplished without damage to concrete to prevent excessive stress in concrete from swelling of forms. Construct forms for openings to facilitate loosening.
- B. Do not remove forms until concrete strength is such that form removal will not result in perceptible cracking, spalling, or breaking of edges or surfaces, or other damage to concrete.
- C. Remove forms in a manner which prevents damage to concrete.
- D. Repair damaged concrete in accordance with Section 03 30 00 – Cast-in-Place Concrete.
- E. Begin required repair and curing immediately after form removal.

**END OF SECTION**

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## **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid rusting.
- B. Protect from contaminants such as grease, oil, and dirt.
- C. Furnish identification after bundles are broken and tags removed.

## **PART 2 PRODUCTS**

### **2.01 STEEL REINFORCING**

- A. Reinforcing Bars:
  - 1. ASTM A615, Grade 60; or ASTM A996, Type A, Grade 60.
  - 2. Deformed steel bar.
- B. Reinforcing Fabric: Electrically-welded wire fabric.
- C. Dowel Bar System:
  - 1. Smooth Dowel Bars: ASTM A615, Grade 50, plain round.
  - 2. Speed Dowel System, as manufactured by Greenstreak, Inc. [www.greenstreak.com](http://www.greenstreak.com) or equal having the following essential characteristics:
    - a. Manufactured to accept smooth bars.
    - b. Two component system, including a closed end sleeve to allow for axial movement and a reusable attachment base.
    - c. Compressibility of the system shall exceed 4,500 lbs/in<sup>2</sup>.

### **2.02 ACCESSORIES**

- A. Chairs, hangers, spacers, and other supports:
  - 1. Material: Concrete, metal or other approved material:
    - a. Compressive strength of precast concrete blocks: Equal to or greater than surrounding concrete.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Clean reinforcement surfaces of heavy, flaky rust; loose mill scale; dirt; grease; and other foreign substances before placement.

- B. Field bending not allowed unless approved by COR:
  - 1. Do not use heat to bend.
- C. Do not use torch to cut.
- D. Accurately place reinforcement:
  - 1. Place reinforcement as shown on Standard Drawing 40-D-60003, unless otherwise shown on reinforcement design drawings.
  - 2. Unless otherwise prescribed, placement dimensions shall be to centerline of the bars.
  - 3. Place reinforcement with a clear distance of 1-inch, minimum, between reinforcement and anchor bolts, form ties, or other embedded metalwork unless otherwise shown on drawings.
- E. Splices:
  - 1. Locate where shown on drawings, unless otherwise approved by COR.
  - 2. Reinforcement may be spliced at additional locations for the convenience of Contractor, subject to approval of COR.
- F. Do not weld or tack weld reinforcing bars.
- G. Secure reinforcement in place so that it will not be displaced during concrete placement.
- H. Do not disturb reinforcement in concrete that has been placed.
- I. Tolerances:
  - 1. Maintain concrete cover over reinforcement within 1/2-inch of specified cover where specified cover is greater than 2 1/2-inches.
  - 2. Maintain concrete cover over reinforcement within 1/4-inch of specified cover where specified cover is 2 1/2-inches or less.
  - 3. Maintain spacing of reinforcing bars within 1-inch of required spacing.
- J. Embedded Dowels:
  - 1. Place dowels at locations shown on drawings.
  - 2. Position dowels parallel to each other and to concrete surface as shown on drawings.
  - 3. Maintain dowels accurately in position during concrete placement.

**END OF SECTION**

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**SECTION 03 30 00**  
**CAST-IN-PLACE CONCRETE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Pumping Plant Concrete:

1. Measurement: Volume of concrete measured to structure neatlines shown on drawing:
  - a. Where concrete is placed on or against excavated surfaces, measurement will be made to lines for which payment for excavation is made.
  - b. Measurement of other concrete will be made to structure neatlines shown on drawings.
  - c. Volume of openings, recesses, embedded pipes, and metalwork larger than 100 square inches in cross section will be deducted.
2. Payment: Cubic yard price offered in the Price Schedules:
  - a. Includes cost of work and materials for concrete except as specified.
  - b. No payment will be made for concrete that is wasted; replacement of damaged or defective concrete; concrete used to fill overexcavated areas; and concrete placed by the Contractor in excavations intentionally performed to facilitate the Contractor's operations.
  - c. Includes cost of cementitious materials.

B. Turnout Building Concrete:

1. Measurement: Volume of concrete measured to structure neatlines shown on drawing:
  - a. Where concrete is placed on or against excavated surfaces, measurement will be made to lines for which payment for excavation is made.
  - b. Measurement of other concrete will be made to structure neatlines shown on drawings.
  - c. Volume of openings, recesses, embedded pipes, and metalwork larger than 100 square inches in cross section will be deducted.
2. Payment: Cubic yard price offered in the Price Schedules:
  - a. Includes cost of work and materials for concrete except as specified.
  - b. No payment will be made for concrete that is wasted; replacement of damaged or defective concrete; concrete used to fill overexcavated areas; and concrete placed by Contractor in excavations intentionally performed to facilitate Contractor's operations.
  - c. Includes cost of cementitious materials.

C. Chemical Building Concrete:

1. Measurement: Volume of concrete measured to structure neatlines shown on drawing:
  - a. Where concrete is placed on or against excavated surfaces, measurement will be made to lines for which payment for excavation is made.
  - b. Measurement of other concrete will be made to structure neatlines shown on drawings.
  - c. Volume of openings, recesses, embedded pipes, and metalwork larger than 100 square inches in cross section will be deducted.
2. Payment: Cubic yard price offered in Price Schedule 2 (Pumping Plant No. 7):
  - a. Includes cost of work and materials for concrete except as specified.
  - b. No payment will be made for concrete that is wasted; replacement of damaged or defective concrete; concrete used to fill overexcavated areas; and concrete placed by Contractor in excavations intentionally performed to facilitate Contractor's operations.
  - c. Includes cost of cementitious materials.

D. Cost:

1. Include cost of concrete for the following items, in applicable prices offered in the Price Schedules:
  - a. Encasements and blocking for Steel Manifold Pipe.
  - b. Chain link fences.
  - c. Foundations for evaporative cooler(s), engine generator, switchgear, and water storage tank overflow apron.
  - d. Includes cementitious materials and reinforcing.

**1.02 ACRONYMS**

- A. NRMCA: National Ready Mixed Concrete Association.

**1.03 DEFINITIONS**

- A. Supplementary Cementitious Materials (SCM): Cementitious materials other than Portland cement.

**1.04 REFERENCE STANDARDS**

- A. American Concrete Institute (ACI)

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. ACI 117-10</li> <li>2. ACI 201.2R-16</li> </ol> | <p>Tolerances for Concrete Construction and Materials</p> <p>Guide to Durable Concrete</p> |
|---|--|

3.	ACI 301-16	Structural Concrete
4.	ACI 304R-00	Guide for Measuring, Mixing, Transporting, and Placing Concrete
5.	ACI 305.1-14	Hot Weather Concreting
6.	ACI 306.1-90(2002)	Cold Weather Concreting
B.	ASTM International (ASTM)	
1.	ASTM C31/C31M-18	Making and Curing Concrete Test Specimens in the Field
2.	ASTM C33/C33M-16e1	Concrete Aggregates
3.	ASTM C39/C39M-18	Compressive Strength of Cylindrical Concrete Specimens
4.	ASTM C42/C42M-16	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5.	ASTM C94/C94M-17a	Ready-Mixed Concrete
6.	ASTM C114-15	Chemical Analysis of Hydraulic Cement
7.	ASTM C117-17	Materials Finer than 75- $\mu\text{m}$ (No. 200) Sieve in Mineral Aggregates by Washing
8.	ASTM C136-14	Sieve Analysis of Fine and Coarse Aggregates
9.	ASTM C138/C138M-17a	Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
10.	ASTM C143/C143M-15a	Slump of Hydraulic-Cement Concrete
11.	ASTM C150/C150M-17	Portland Cement
12.	ASTM C171-16	Sheet Materials for Curing Concrete
13.	ASTM C231/C231M-17a	Air Content of Freshly Mixed Concrete by the Pressure Method
14.	ASTM C260/C260M-10a(2016)	Air-Entraining Admixtures for Concrete
15.	ASTM C295/C295M-12	Petrographic Examination of Aggregates for Concrete
16.	ASTM C309-11	Liquid Membrane-Forming Compounds for Curing Concrete
17.	ASTM C494/C494M-17	Chemical Admixtures for Concrete
18.	ASTM C566-13	Total Evaporable Moisture Content of Aggregate by Drying
19.	ASTM C595/C595M-17	Blended Hydraulic Cements

- |     |                                      |   |
|-----|--------------------------------------|---|
| 20. | ASTM C618-17a                        | Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete   |
| 21. | ASTM C920-18                         | Elastomeric Joint Sealants  |
| 22. | ASTM C989/C989M-17                   | Slag Cement for Use in Concrete and Mortars   |
| 23. | ASTM C1017/C1017M-13e1               | Chemical Admixtures for Use in Producing Flowing Concrete   |
| 24. | ASTM C1064/C1064M-17                 | Temperature of Freshly Mixed Hydraulic-Cement Concrete  |
| 25. | ASTM C1260-14                        | Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)   |
| 26. | ASTM C1293-08b(2015)                 | Determination of Length of Change of Concrete Due to Alkali-Silica Reaction   |
| 27. | ASTM C1315-11                        | Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete   |
| 28. | ASTM C1567-13                        | Determining the Potential Alkali-Silica Reactivity of Combination of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)                             |
| 29. | ASTM C1602/C1602M-12                 | Mixing Water Used in the Production of Hydraulic Cement Concrete  |
| 30. | ASTM D395-16e1                       | Rubber Property – Compression Set   |
| 31. | ASTM D471-16a                        | Rubber Property – Effect of Liquids   |
| 32. | ASTM D792-13                         | Density and Specific gravity (Relative Density) of Plastics by Displacement   |
| 33. | ASTM D1751-04(2013)e1                | Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)  |
| 34. | ASTM D1752-04a(2013)                 | Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction   |
| 35. | ASTM D2240-15e1                      | Rubber Property – Durometer Hardness  |
| C.  | U.S. Army Corps of Engineers (USACE) |   |
| 1.  | USACE CRD-C 662-10                   | Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method) |

- D. International Concrete Repair Institute (ICRI)
1. ICRI 310.2-13 Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays (formerly No. 03732)
- E. International Organization for Standardization (ISO)
1. ISO 8067-2008 Flexible cellular polymeric materials – Determination of tear strength.
- F. Bureau of Reclamation (Reclamation)
1. USBR M-47 Standard Specifications for Repair of and Maintenance of Concrete, August 2015 (Part 2 of “Guide to Concrete Repair, Second Edition” available at [www.usbr.gov/tsc/techreferences/mands/mands-pdfs/guide.pdf](http://www.usbr.gov/tsc/techreferences/mands/mands-pdfs/guide.pdf))
  2. USBR Concrete Manual Concrete Manual, Eighth Edition, Revised Reprint, 1981
- G. National Sanitation Foundation International (NSF)
1. NSF/ANSI 61-16 Drinking Water System Components - Health Effects

## 1.05 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 03 30 00-1, Approval Data:
1. Mix Design: For each concrete mix:
    - a. Mixture proportions.
    - b. Material sources:
      - 1) Name and manufacturer of each cementitious material:
        - a) Cementitious Materials Certification and Test Reports:
          - i. Less than 3-months old.
      - 2) Name of aggregate source(s).
      - 3) Product name and manufacturer of admixtures to be used in mix. Certify that admixtures:
        - a) Contain no purposefully added chlorides.
        - b) Chloride ion limits in accordance with ACI 201.2R.

- 4) Government reserves the right to require submission of samples of concrete materials for testing before or during use in concrete.
  - c. Physical properties:
    - 1) Compressive strength:
      - a) Test data: ACI 301, paragraph 4.2.3.4.
      - b) Field test data: Performed within past 24-months.
      - c) Trial mixtures:
        - i. Incorporate admixtures that will be used in production mixes into trial mixes.
        - ii. Results from trial batches made within past 6-months.
        - iii. Trial mix test results, three (3) 6-inch diameter cylinders each at 7-, and 28-days.
        - iv. Average compressive strength of trial batch cylinders at specified design age.
    - d. Resubmit mix design for change in material source or type.
  2. Name and manufacturer of curing compounds, and joint filler:
    - a. Include application instructions for curing compound.
  3. Aggregate and Water Certifications and test reports:
    - a. Sealed by Professional Engineer.
    - b. Less than 12-months old.
    - c. Certifications and test reports:
      - 1) Aggregate producer for:
        - a) ASTM C33 physical properties
        - b) ASR testing reports for each aggregate source.
      - 2) Mixing water: ASTM C1602.
    - d. Submittal of certifications and test reports shall not relieve Contractor of responsibility for furnishing materials meeting specified requirements.
- C. RSN 03 30 00-2, Concrete Placement Schedule:
1. Complete, detailed concrete placement schedule showing Contractor's plan for individual placements including placement of reinforcement and embedded items.
  2. Detail as necessary to show location, sequence, and date of concrete placements scheduled for each item of concrete work.
  3. Show submittal schedule for placement and reinforcement drawings.

D. RSN 03 30 00-3, Certifications:

1. NRMCA Certification of Production Facilities. NRMCA certification shall be current and include automatic digital recording of cementitious materials, aggregate, water, and chemical admixtures. NRMCA certification shall be maintained throughout duration of project.
2. ACI Aggregate Testing Technician certification(s).
3. ACI Concrete Field-Testing Technician certification(s).
4. ACI Concrete Strength Testing Technician certification(s).

E. RSN 03 30 00-4, Test Reports:

1. Aggregate test results as required by Table 03 30 00B - Contractor Batch Plant Quality Testing.
2. Concrete test reports as required by Table 03 30 00E - Contractor Field Quality Testing.

## 1.06 QUALIFICATIONS

- A. Ready mix plant: Currently certified by NRMCA. NRMCA certification shall include automatic digital recording of cementitious materials, aggregate, water, and chemical admixtures. NRMCA certification shall be maintained throughout duration of project.
- B. ACI Aggregate Testing Technician: Currently certified ACI Aggregate Testing Technician - Level 1.
- C. Flatwork foreman with at least 5-years of experience with similar type placements.
- D. ACI Concrete Field-Testing Technician: Currently certified ACI Concrete Field Testing Technician - Grade I.
- E. ACI Strength Testing Technician: Currently certified ACI Strength Testing Technician.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Furnish legible and digitized batch ticket with each batch of concrete in accordance with ASTM C94. Deliver ticket to COR at jobsite during batch delivery.
- B. Sponge rubber joint filler storage:
  1. Store in protected area at temperature of 70 degrees F (21 degrees C) or less.
  2. Do not expose to direct sun.

## 1.08 PRE-PLACING MEETING

- A. At least 14-days before first concrete placement meet with COR for pre-placement meeting.

- B. Coordinate time and place of meeting with COR at least 14-days before meeting.
- C. Contractor attendees shall be at least the following:
  - 1. Contractor onsite supervisor.
  - 2. Concrete forming, placing, and finishing onsite supervisor(s); Contractor or subcontractor(s) employee as applicable.
  - 3. Technical specialist from ready-mix supplier.
  - 4. Concrete pump subcontractor onsite supervisor, if applicable.
  - 5. Testing agency onsite supervisor(s).

## **PART 2 PRODUCTS**

### **2.01 CEMENTITIOUS MATERIALS**

- A. Portland cement:
  - 1. ASTM C150, Type V:
    - a. Meet equivalent alkalis requirements of ASTM C150 - Table 2:
      - 1) Low-alkali limitation for Portland cement may be waived when tests of concrete aggregate source show that low-alkali cement is not required for ASR mitigation. See Concrete Aggregate Materials article (2.03).
    - b. Meet false-set requirements of ASTM C150 - Table 4.
- B. Blended hydraulic cement:
  - 1. ASTM C595, Type IS or IP.
  - 2. Meet equivalent alkalis requirement of ASTM C595, Table 2, Option G or Table 3.
- C. SCM:
  - 1. Pozzolan:
    - a. ASTM C618, Class F:
      - 1) Except:
        - a) Sulfur trioxide, maximum: 4.0 percent.
        - b) Loss on ignition, maximum: 2.5 percent.
      - 2) In addition:
        - a) Meets Effectiveness in Controlling Alkali-Silica Reaction in Table 3 Supplementary Optional Physical Requirements of ASTM C618.

- b) Calcium oxide, maximum: 8.0 percent.
- c) Pozzolan “R” factor less than 2.5. Pozzolan with this “R” factor shall not decrease sulfate resistance of concrete:
  - i. R: (C-5)/F
  - ii. C: Calcium oxide content of pozzolan in percent determined in accordance with ASTM C114.
  - iii. F: Ferric oxide content of pozzolan in percent determined in accordance with ASTM C114.

2. Slag Cement:

- a. ASTM C989, Grade 100 or 120.

## 2.02 WATER

- A. ASTM C1602, including optional requirements of Table 2.

## 2.03 AGGREGATE MATERIALS

- A. Fine aggregate: ASTM C33:

- 1. Percent material passing No. 200 sieve: Less than 3 percent.

- B. Coarse aggregate: ASTM C33, Class 4S, Size No. specified in Table 03 30 00A - Concrete Mixes.

- C. Alkali Silica Reaction (ASR):

- 1. Test fine and coarse aggregates in accordance with ASTM C1260 for potential deleterious ASR:
  - a. For ASTM C1260, and other tests when required, continue readings for 28-days after zero readings.
  - b. Acceptance criteria specified below are based on 28-day readings after zero readings.
  - c. Expansion is no greater than 0.10 percent: Aggregates are acceptable.
  - d. Expansion is greater than 0.10 percent:
    - 1) Test aggregates according to ASTM C1567 using components (e.g. coarse aggregate, fine aggregate, cementitious materials, and ASR inhibiting admixtures) in proportions proposed for mixture design:
      - a) For mixes using lithium admixtures use test procedure USACE CRD-C 662.
      - b) Expansion of proposed mixture design test specimens, tested in accordance with ASTM C1567 does not exceed 0.10 percent:
        - i. Aggregates are acceptable.

- c) Expansion of proposed mixture design test specimens is greater than 0.10 percent:
        - i. Aggregates are not acceptable unless adjustments to mixture design can reduce expansion to less than 0.10 percent or testing by ASTM C1293 indicates aggregates will not experience deleterious expansion.
    - 2) Use tested materials. Materials may be rejected if they do not match tested materials.
  - 2. ASTM C1293 test results may be substituted for ASTM C1260 test results:
    - a. Average ASTM C1293 concrete prism expansion less than 0.04 percent at one year: Aggregates acceptable.
- D. Appropriate for use in accordance with ASTM C295.

## **2.04 ADMIXTURES**

- A. Air-entraining admixture: ASTM C260.
- B. Chemical admixtures:
  - 1. Do not use chemical admixtures which contain more than 0.1 percent chloride, by weight.
  - 2. Admixtures shall be compatible with each other.
  - 3. Allowable chemical admixtures:
    - a. ASTM C494, Type A, D, F, G, or S.
    - b. ASTM C1017, Type I or II.
    - c. ASTM C494, Type C and E, provided they do not contain chlorides.
- C. Specialized chemical admixtures:
  - 1. When batch plant has not previously used a specialized chemical admixture, admixture manufacturer shall provide on-site representative to assist with mix design and to train batch plant personnel in dispensing and mixing operations.
  - 2. Do not use specialized chemical admixtures which contain more than 0.1 percent chloride, by weight.
  - 3. Alkali Silica Reaction (ASR) Inhibiting Admixture:
    - a. Lithium Nitrate Admixture for ASR mitigation of reactive aggregates having the following characteristics:
      - 1) Meets NSF/ANSI 61.
      - 2) Nominal 30 percent aqueous solution of Lithium Nitrate:
        - a) Density: 10 pounds/gallon (1.2 kg/L).

- b) Approximate chemical constituents (percent by mass):
      - i. LiNo<sub>3</sub> (Lithium Nitrate): 30 plus or minus 0.5.
      - ii. SO<sub>4</sub>-2 (Sulfate Ion), maximum: 0.1.
      - iii. Cl<sup>-</sup> (Chloride Ion), maximum: 0.2.
      - iv. NA<sup>+</sup> (Sodium Ion), maximum: 0.1.
      - v. K<sup>+</sup> (Potassium Ion), maximum: 0.1.
    - b. Coordinate with manufacturer regarding Lithium Nitrate dosage.
    - c. Do not use Lithium Nitrate Admixture for concrete in continuous or nearly continuous contact with water.
  - 4. Extended set control admixture:
    - a. MasterSet Delvo hydration controlling admixture manufactured by BASF Construction Chemicals, Inc. [www.basf-admixtures.com](http://www.basf-admixtures.com); or equal, with the following essential characteristics:
      - 1) Meets ASTM C494, Type B.
      - 2) Retards setting.
      - 3) Does not reduce concrete strength.
    - b. Use within manufacturer's time limits.
    - c. Include admixture on batch ticket.
    - d. Admixture quantity required to stabilize concrete shall be pre-determined using jobsite materials. Initial concrete setting time shall be monitored and adjusted during project by qualified concrete technician.

## 2.05 CURING MATERIALS

- A. Water: ASTM C1602, including optional requirements of Table 2.
- B. Curing compound: ASTM C309:
  - 1. Capable of meeting moisture retention at manufacturer's application rate.
  - 2. Meet Federal, State, Tribal and local regulations for VOCs.
- C. Sheet materials:
  - 1. Polyethylene film: ASTM C171, white opaque.
  - 2. White burlap-polyethylene sheeting: ASTM C171.

## 2.06 ACCESSORIES

- A. Sponge rubber joint filler:
  - 1. ASTM D1752, Type I, except:
    - a. Test specimen compression load: 50 to 150 pounds per square inch.

2. Joint filler adhesive: Nonbituminous adhesive recommended by filler manufacturer.
- B. Bituminous joint filler: ASTM D1751.
- C. Elastomeric sealant: ASTM C920, polyurethane, Use M, Grade NS, Class 25.
- D. Evaporation control:
1. MasterKure ER 50 manufactured by BASF Construction Chemicals, Inc., [www.basf-admixtures.com](http://www.basf-admixtures.com); or equal having the following essential characteristics:
    - a. Monomolecular film forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
    - b. For application after finishing and prior to applying curing compound.
    - c. For use when the evaporation rate is high.
  2. Do not use as finishing aid.
- E. Mastic Waterstop:
1. Earth Shield Type NB190 Modified Chloroprene Strip Applied Waterstop – Profile B as manufactured by JP Specialties, Inc., [www.earthshield.com](http://www.earthshield.com); or equal having the following essential characteristics:
    - a. Waterstop shall be chloroprene hydrophilic rubber and contain no bentonite
    - b. Performance Requirements as follows:

Property	Tests Method	Required Limits
Pressure Resistance		231 ft of Water Head Pressure
Hardness (Shore A)	ASTM D2240	36.4
Specific Gravity	ASTM D792	1.46
Tear Resistance	ISO 8067	5.56 lb/inch
Compression Set	ASTM D395	45 percent at 77 degrees F
Swelling (Fresh Water)		400 percent in 36-days
Swelling (Saltwater)		46 percent in 36-days
Chemical Resistance	ASTM D471	Meet or exceed specific testing standards for contained fluids as required by Owner and certified by Manufacturer.

- c. Secure waterstop to dry concrete surface per manufacturer recommendations.
- d. Splice and/or connect waterstop per manufacturer's recommendations.

**2.07 MIX**

- A. Contractor shall design and adjust concrete mix:
1. Government reserves the right to adjust mix proportions when need for adjustment is indicated by results of materials testing:
    - a. When required, adjustment of mix proportions by Government will be in accordance with USBR Concrete Manual.
- B. Cementitious materials options:
1. Specified Portland cement plus specified pozzolan by percent weight specified in Table 03 03 00A - Concrete Mixes.
  2. Specified Portland cement plus specified slag cement by percent weight specified in Table 03 03 00A - Concrete Mixes.
  3. Blended Hydraulic: ASTM C595 provided, specified Portland cement with percent of specified pozzolan or specified slag cement specified in Table 03 30 00A - Concrete Mixes.
- C. Design concrete mixes in accordance with Table 03 30 00A - Concrete Mixes. General concrete mix shall be used for concrete unless otherwise specified:
1. Net water-cementitious materials ratio (w/c) is maximum, by weight. Cementitious material weight is cement plus SCM.
  2. Slump at point of placement: In accordance with ASTM C143.
  3. Air Entrainment: Percent air by volume of concrete as discharged at point of placement, in accordance with ASTM C231.

Table 03 30 00A – Concrete Mixes

Mix No	Feature	f'c (lb/in <sup>2</sup> )	Max w/c*	NMSA **	Percent SCM*** A: Class F Pozzolan B: Slag Cement	Slump (inches)	Air Content (percent)	Notes
1	Foundations, Structural Concrete Pipe Encasement/ Thrust Blocks and General Concrete	4500 at 28-days	0.45	57, 67	A: 20 plus or minus 5	2 to 4	4.5 to 7.5	1,2

Table 03 30 00A – Concrete Mixes

Mix No	Feature	f'c (lb/in <sup>2</sup> )	Max w/c*	NMSA **	Percent SCM*** A: Class F Pozzolan B: Slag Cement	Slump (inches)	Air Content (percent)	Notes
2	Interior Slab on Grade	4500 at 28-days	0.45	57, 67	A: 20 plus or minus 5	2 to 4	Non-Air Entrained	1, 2

\*Maximum water/cementitious materials ratio.

\*\*Nominal Maximum Size Aggregate.

\*\*\*SCM as percent of total cementitious material, by weight.

NOTES:

1. Ternary blended cementitious materials which meet the specifications may be submitted for approval.
  2. Concrete with ASTM C1017, Type I or II plasticizing admixtures, ASTM C494 Type F high-range water-reducing admixtures, or Type G high-range water-reducing and retarding admixtures:
    - a. Admixture shall be incorporated into trial batch or historical data.
    - b. Use slump appropriate for placing conditions.
- D. Submit design mixes for each type and strength of concrete substantiated by either laboratory trial batch or field performance methods as specified in ACI 301. For trial batch method, mix shall be proportioned and stamped by a professional engineer.
- E. Concrete trial mixes:
1. Average compressive strength of trial batch cylinders at design age: Design strength plus 1,200 pounds per square inch for concrete between 3,000 and 5,000 psi.
  2. Admixtures to be used in mix shall be incorporated into mix design submitted for approval.
  3. Air content: Within 1 percent of top of specified range.
  4. Slump: Within 1-inch of top of specified range.

## 2.08 BATCHING, MIXING, AND TRANSPORTING

- A. Batch plant: Currently NRMCA certified with automatic digital recording of cementitious materials, aggregate, water, and chemical admixtures.
- B. Manufacture and deliver in accordance with ASTM C94 and ACI 304R:
  1. Prepare batch ticket in accordance with ASTM C94 for every batch of concrete.

- C. Cold weather: When air temperature has fallen to or is expected to fall below 40 degrees F, prepare ingredients and mix in accordance with ACI 306.1:
  - 1. Do not use frozen materials or materials containing ice or snow.
  - 2. Uniformly heat water and aggregates before mixing to obtain concrete mixture temperature of not less than 50 degrees.
- D. Hot Weather: When precautions are necessary, prepare ingredients and mix in accordance with ACI 305.1:
  - 1. Cool ingredients before mixing to maintain specified maximum concrete temperature at time of placement.
  - 2. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Ice replacing batch water shall be melted prior to discharge.
  - 3. Using liquid nitrogen to cool concrete is Contractor's option.
- E. Prevent appreciable segregation of ingredients.
- F. Place concrete within 90-minutes from introduction of cement to water or aggregates:
  - 1. For placing times exceeding 90-minutes, extended set control admixtures may be used when approved by COR.

## **2.09 CONCRETE TEMPERATURE**

- A. Concrete temperature at placing:
  - 1. 50 to 85 degrees F (10 to 29 degrees C).

## **2.10 CONTRACTOR SOURCE QUALITY TESTING**

- A. Perform sampling, testing, and reporting as required in Table 03 30 00B - Batch Plant Testing:
  - 1. Independent testing agency shall meet requirements specified in Section 01 46 20 – Testing Agency Services.
  - 2. Personnel conducting tests: Qualified as ACI Aggregate Testing Technician, Level 1; or equal.
- B. Perform tests at least as often as frequencies specified in Table 03 30 00B - Batch Plant Testing.
- C. Notify COR immediately of test results showing failure of materials to meet specifications. Provide passing test to COR within 24-hours. Submit reports of test results as specified.

## 2.11 BATCH PLANT TESTING

Table 03 30 00B- Batch Plant Testing

TESTS OF	TEST STANDARD	STANDARD TITLE	REQUIREMENT	TESTING FREQUENCY
Aggregate Gradation	ASTM C136	Sieve Analysis of Fine and Coarse Aggregates	Fine and Coarse Aggregate meets sizing requirements per ASTM C33.	At beginning of placing each mix. At change in mix design. At least every 500 yd <sup>3</sup> of placing a mix.
Aggregate Fines content	ASTM C117	Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing	Fine aggregate meet specified allowable fines content (material passing No. 200 sieve)	At beginning of placing each mix. At change in mix design. At least every 500 yd <sup>3</sup> of placing a mix.
Aggregate moisture content	ASTM C566	Total Evaporable Moisture Content of Aggregate by Drying	Verify that moisture meter at batch plant is accurate with the material batched.	At beginning of placing each mix. At change in mix design. At least every 500 yd <sup>3</sup> of placing a mix.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Remove standing water, mud, and debris from foundation surfaces to be covered by concrete.
- B. Prepare rock surfaces free from oil, objectionable coatings, and loose, semidetached, and unsound fragments. Immediately before placement of concrete, wash rock surfaces with air-water jet and dry to uniform surface-dry condition.
- C. Prepare earth foundations free from frost or ice.
- D. Thoroughly moisten surfaces of absorptive foundations to be covered with concrete so that moisture will not be drawn from fresh concrete. Keep subgrade moisture uniform without puddles or dry areas.

- E. Clean, roughen, and surface dry surfaces of construction joints to be covered with fresh concrete:
  - 1. Remove laitance, loose or defective concrete, coatings, and sand, curing compound, and other foreign material.
  - 2. Sandblast, steel shotblast, or high-pressure water jet surfaces, or use other method approved by COR to create a surface equivalent to or larger than CSP 5 in accordance with ICRI 310.2.
  - 3. Wash surface thoroughly, and surface dry immediately before placement of adjoining concrete.

### **3.02 PLACING**

- A. Notify COR at least 24-hours before placing concrete.
- B. Provide placement checkout cards in a watertight container. COR will approve placement card format:
  - 1. Sign each line item indication work is completed in accordance with specifications.
  - 2. Obtain COR signature after each line item.
  - 3. Do not place concrete without required signatures.
  - 4. Use of placement checkout cards shall be required by COR.
- C. Do not place concrete without approval of COR.
- D. Place concrete in presence of COR.
- E. Perform concrete placing under the direct supervision of a qualified flatwork foreman for placements.
- F. Allow at least 7-days between adjacent placements, or as approved by COR.
- G. Do not use aluminum pipes and chutes for placing or pumping concrete.
- H. Adding water to concrete batch at site will be allowed only once and only when approved by the COR:
  - 1. Add additional water before concrete is discharged.
  - 2. Do not exceed specified water to cement ratio.
  - 3. After water is added, concrete shall be mixed for at least 30 revolutions of mixer drum at mixing speed.
  - 4. Record added water on batch ticket to nearest gallon.
- I. Adding air entraining admixtures to concrete batch at site will be allowed only once when approved by COR:

1. After air entraining admixture is added, concrete shall be mixed for minimum of 30 revolutions of mixer drum at mixing speed.
  2. Take slump and air content after air-entraining admixture addition and additional revolutions.
  3. Record added air entraining admixture on batch ticket to nearest ounce.
- J. Do not use concrete which has become so stiff that concrete cannot be properly placed.
- K. Place formed concrete in continuous, approximately horizontal layers. Do not exceed 20-inches in depth of layers.
- L. Vibrate concrete until concrete has been consolidated to maximum practical density, is free from pockets of coarse aggregate, and closes snugly against surfaces of forms and embedded materials.
- M. Hot Weather:
1. Place concrete in accordance with ACI 305.1.
  2. Protect reinforcing steel so that steel temperature does not exceed ambient air temperature immediately before placing concrete.
  3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
- N. Cold weather:
1. Place concrete in accordance with ACI 306.1.
  2. Do not place concrete on frozen subgrade or subgrade containing frozen materials.

### **3.03 FINISHING**

- A. Notify COR before finishing concrete.
- B. Finish concrete in presence of Government inspector unless inspection is waived in each specific case:
1. Perform placement finishing under the direct supervision of qualified flatwork foreman.
- C. Finish surfaces as specified in Table 03 30 00F - Formed Surfaces and Table 03 30 00G - Unformed Surfaces.
- D. Where finishes are not specified or shown on drawings for particular surface, finish concrete as specified for similar work.
- E. Formed surfaces:
1. Finish class is designated by symbols F1, F2.

2. Finish F1:
    - a. Applies to formed surfaces to be covered by fill material, grout, or concrete, and construction joint surfaces as specified in Table 03 30 00F - Formed Surfaces.
    - b. Protect form tie rod ends on surfaces in contact with fill material from moisture where they will be below water table or waterline:
      - 1) Recess tie rod ends and fill recess with dry pack or other material approved by COR.
    - c. Cut off flush with formed surface form tie rod ends on surfaces in contact with concrete or fill material and above maximum water table or waterline elevation.
  3. Finish F2:
    - a. Applies to exposed formed surfaces not permanently concealed by fill material, grout, or concrete, and to contraction joint surfaces and expansion joint surfaces as specified in:
      - 1) Recess tie rod ends and fill recess with dry pack or other material approved by COR.
- F. Unformed surfaces:
1. Do not use dry Portland cement or additional water during finishing.
  2. Do not use “jitterbugs” or other tools to force coarse aggregate away from surface.
  3. Finish class is designated by symbols U1, U2, U3 or broom finish.
  4. Finish U1 (Screeded Finish):
    - a. Applies to unformed surfaces to be covered by fill material, grout, or concrete as specified in Table 03 30 00G - Unformed Surfaces.
    - b. Use as first stage of finish U2.
    - c. After concrete is placed and consolidated, strike off and level concrete to produce even uniform surface.
  5. Finish U2 (Floated Finish):
    - a. Applies to unformed surfaces not permanently concealed by fill material, grout, or concrete, as specified in Table 03 30 00G - Unformed Surfaces.
    - b. Begin floating as soon as screeded surface has sufficiently stiffened and bleed water sheen has disappeared.
    - c. Use hand- or power-driven equipment.
    - d. Finish surface with minimum floating necessary to produce surface that is free of screed marks and is uniform in texture.

- e. Use as second stage of finish U3. Floating shall bring a small amount of mortar without excess water to the surface, so as to permit effective troweling.
6. Finish U3 (troweled finish):
    - a. Applies to unformed surfaces where appearance and porosity is considered by Government to be of special importance as specified in Table 03 30 00G – Unformed Surfaces.
    - b. Begin steel troweling after bleed water has disappeared and floated surface has sufficiently hardened to prevent an excess of fine material from being drawn to surface.
    - c. Trowel with firm pressure to flatten sandy texture of floated surface.
    - d. Trowel to a dense uniform surface free from blemishes and trowel marks. Do not excessively trowel surface.
  7. Broomed finish:
    - a. Apply broom finish immediately after concrete receives U2 finish.
    - b. Edge transverse joints before brooming.
    - c. Produce a scored surface by brooming with fiber-bristle brush in direction transverse to that of traffic with adjacent strokes slightly overlapping.
    - d. Finished surface shall have uniform appearance and be free of abrupt corrugation exceeding 1/8-inch in depth.
    - e. Brooming shall eliminate flat surface left by the surface face of the edger.
  8. Slope interior surfaces for drainage where shown on drawings or as directed by COR. Slope surfaces exposed to weather for drainage as directed by COR.
  9. Slope narrow surfaces, such as tops of walls and curbs, approximately 3/8-inch per foot of width, unless use of other slopes or level surface is indicated on drawings or is directed by COR.
  10. Slope broader surfaces; such as walks, platform, and decks; approximately 1/4-inch per foot unless use of other slopes or level surfaces is indicated on drawings or is directed by COR

### **3.04 JOINTS AND EDGES**

#### **A. Construction joints (CJ):**

1. Construction joints are joints which are purposely placed in concrete to facilitate construction, reduce initial shrinkage stresses and cracks, allow time for installation of embedded metalwork, or allow for subsequent placing of other concrete.
2. Bond is required at construction joints regardless of whether or not reinforcement is continuous across joint.
3. Locate construction joints where shown on drawings. Relocation, addition, or elimination of construction joints will be subject to approval by COR.

4. Clean, roughen, and surface dry surfaces of construction joints to be covered with fresh concrete. See Preparation article.
  5. Do not use a mortar layer on construction joints.
- B. Control joints (Ct.J):
1. Control joints are joints placed in concrete to provide for control of initial shrinkage stresses and cracks of monolithic units.
  2. Construct control joints so no bond exists between concrete surfaces forming the joint:
    - a. Construct control joints by placing concrete on one side of joint and allowing it to set before concrete is placed on other side of joint.
    - b. Coat surface of concrete first placed at control joint with curing compound that prevents bond before placing concrete on other side of joint.
  3. Reinforcement is continuous across tooled or saw cut control joints.
- C. Partial Contraction Joints, (Partial Cr. J):
1. Construct partial contraction joints so no bond exists between concrete surfaces forming the joint:
    - a. Construct partial contraction joints by placing concrete on one side of joint and allowing it to set before concrete is placed on other side of joint.
    - b. Coat surface of concrete first placed at partial contraction joint with curing compound that prevents bond before placing concrete on other side of joint.
  2. At partial contraction joints, discontinue every other reinforcement bar perpendicular to the joint; i.e. 1/2 of perpendicular reinforcement shall cross the joint. End discontinued bars 2-inches from face of joint.
- D. Contraction joints (Cr.J):
1. Contraction joints are joints placed in concrete to provide for volumetric shrinkage of a monolithic unit or movement between monolithic units.
  2. Construct contraction joints so no bond exists between concrete surfaces forming the joint:
    - a. Construct contraction joints by placing concrete on one side of joint and allowing it to set before concrete is placed on other side of joint.
    - b. Coat surface of concrete first placed at contraction joint with curing compound that prevents bond before placing concrete on other side of joint.
  3. Except as provided for dowels, reinforcement is not continuous across a contraction joint.
- E. Expansion joints (EJ):

1. Cut sponge rubber joint filler to size and shape of joint surface to receive filler.
  2. Adhere filler to concrete in accordance with adhesive manufacturer's recommendations.
  3. Butt sections of filler with tight-fitting butt joints to prevent mortar from seeping through joint.
- F. Expansion joints (EJ):
1. Form joint in concrete.
  2. Fill joint with bituminous joint filler.
  3. Butt sections of filler with tight-fitting butt joints.
- G. Prefomed joints consisting of plastic or metal strips not allowed.

### **3.05 STRUCTURAL DEVIATIONS AND SURFACE TOLERANCES**

- A. Structural deviations are defined as allowable variations from specified lines, grades, and dimensions.
- B. Surface tolerances are defined as maximum allowable magnitude of surface irregularities.
- C. Specified structural deviations and surface tolerances are consistent with modern construction practice and governed by effects that permissible variations may have upon a structure. COR reserves the right to diminish specified structural deviations and surface tolerances where such variations impair structural action, operational function, or architectural appearance of a structure or portion of structure.
- D. Construct concrete within stated variations even though more than one may be specified:
1. Specified variation for one element of a structure will not apply when it will permit another element of same structure to exceed its allowable variation.
  2. Where variations are not specified or shown on drawings for a particular structure, variations shall be those specified for similar work. As an exception to clause at FAR 52.236-21 "Specifications and Drawings for Construction", specific tolerances shown on drawings in connection with dimension shall govern.
- E. Structural Deviations:
1. Check variations from specified lines, grades, and dimensions in hardened concrete to determine that structures are within tolerances specified in Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions.
  2. Variation is distance between actual position of structure or element of structure and specified position in plan for structure or particular element:
    - a. Plus, or minus variations indicate a permitted actual position up or down and in or out from specified position in plan.

- b. Variations not designated as plus or minus indicate maximum deviation permitted between designated successive points on completed element of construction.
3. Specified position in plan is defined as lines, grades, and dimensions described in this section, shown on drawings, or prescribed by COR.

Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions

A. POWERPLANT AND PUMPING PLANT STRUCTURES AND OTHER BUILDINGS		
1.	Footings:	
(a)	Variation in length and width dimensions from those specified .....	-1/2 inch +2 inches
(b)	Horizontal misplacement or eccentricity:.....	2 percent of footing width in direction of misplacement, but not more than 2 inches
(c)	Reduction in thickness.....	5 percent of specified thickness
2.	Variation of horizontal dimensions at all floor and roof levels from specified position in plan:	
(a)	Overall building dimensions .....	$\pm 1/2$ inch per 100-foot length with maximum for entire length of $\pm 1$ inch
(b)	Overall bay dimensions limited by (c)below, but not to exceed.....	$\pm 3/8$ inch
(c)	Intermediate dimensions for column, wall, and partition locations:	
	For dimensions less than 10-feet .....	$\pm 1/4$ inch
	For dimensions equal to or greater than 10-feet but less than 20-feet.....	$\pm 3/8$ inch
	For dimensions 20-feet or more .....	$\pm 1/2$ inch

Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions

3.	Variation of vertical dimensions from specified position in plan:	
(a)	Overall building dimensions .....	$\pm 1/2$ inch
(b)	Overall story height limited by (c)below, but not to exceed.....	$\pm 3/8$ inch
(c)	Intermediate dimensions:	
	Less than 10-feet .....	$\pm 1/4$ inch
	10- to 20-feet, inclusive.....	$\pm 3/8$ inch
	20-feet or more .....	$\pm 1/2$ inch
4.	Variation from plumb or specified batter for lines and surfaces of columns, piers, walls, and for arrises:	
(a)	When overall height of line or surface is:	
	Less than 10-feet .....	$\pm 1/4$ inch
	10- to 20-feet, inclusive.....	$\pm 3/8$ inch
	More than 20-feet, but less than 40-feet.....	$\pm 1/2$ inch
	40-feet or more .....	$\pm 1$ inch
(b)	For any two successive intermediate points on the line or surface separated by:	
	10- to 20-feet, inclusive.....	1/4 inch
	More than 20-feet .....	3/8 inch
5.	Variation from plumb for lines and surfaces of corner columns, control joint grooves, and other conspicuous lines:	
(a)	When overall height of line or surface is:	
	Less than 10-feet .....	$\pm 1/4$ inch
	10- to 20-feet, inclusive.....	$\pm 3/8$ inch
	More than 20-feet .....	$\pm 1/2$ inch
(b)	For any two successive intermediate points on the line or surface separated by:	
	10- to 20-feet, inclusive.....	1/4 inch
	More than 20-feet .....	3/8 inch

Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions

6.	Variation from level or established grades for floors, roof decks, ceilings, beam soffits, and arrises:	
(a)	When overall length of line or surface is:	
	Less than 10-feet .....	$\pm 1/4$ inch
	10- to 20-feet, inclusive.....	$\pm 3/8$ inch
	More than 20-feet, but less than 40 feet .....	$\pm 1/2$ inch
	40-feet or more .....	$\pm 3/4$ inch
(b)	For any two successive intermediate points on the line or surface separated by:	
	10- to 20-feet, inclusive.....	$1/4$ inch
	More than 20-feet .....	$3/8$ inch
7.	Variation from level or specified grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:	
(a)	When overall length of line or surface is:	
	Less than 10-feet .....	$\pm 1/4$ inch
	10- to 20-feet, inclusive.....	$\pm 3/8$ inch
	More than 20-feet .....	$\pm 1/2$ inch
(b)	For any two successive intermediate points on the line or surface separated by:	
	10- to 20-feet, inclusive.....	$1/4$ inch
	More than 20-feet .....	$3/8$ inch
8.	Variation in location from specified position in plan of sleeves and wall openings .....	$\pm 1/2$ inch
9.	Variation in sizes from those specified for sleeves, floor openings, and wall openings, except wall openings for swinging doors .....	$\pm 1/4$ inch
10.	Variation in sizes from those specified for wall openings for swinging doors .....	-0 inch $+1/4$ inch
11.	Variation in cross-sectional dimensions from those specified for columns and beams and in thicknesses from those specified for slabs and walls .....	- $1/4$ inch $+1/2$ inch

Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions

12.	Variation in rise and tread of steps from that specified:	
(a)	Flight of stairs:	
	Rise .....	±1/8 inch
	Tread .....	±1/4 inch
(b)	Consecutive steps:	
	Rise .....	1/16 inch
	Tread .....	1/8 inch
<b>B. PIPELINE STRUCTURES</b>		
1.	Thrust Blocks, Collars, Anchor Blocks and Miscellaneous Slabs:	
(a)	Departure from established alignment .....	±2-inches
(b)	Departure from established profile grade .....	±2-inches
(c)	Variation from specified thickness .....	-2.5 percent of specified thickness or -1/4-inch, whichever is greater; or +5 percent of specified thickness or +1/2-inch, whichever is greater
(d)	Variation from specified inside dimensions .....	±0.5 percent of inside dimensions
2.	Pre-Cast Manholes:	
(a)	Departure from established alignment .....	±1 inch
(b)	Departure from established profile grade .....	±1 inch
(c)	Variation from plumb or specified batter for lines and surfaces:	
(d)	Variation from specified inside dimensions .....	

Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions

2.	Pre-Cast Manholes:	
(a)	Departure from established alignment .....	±1-inch
(b)	Departure from established grade.....	±1-inch
(c)	Variation from plumb or specified batter for lines and surfaces:	
(1)	When overall length of line or surface is:	
	Less than 10-feet .....	Exposed: ± 3/8-inch Buried: ±3/4-inch
	10-feet or more .....	Exposed: ±1/2-inch Buried: plus, or minus 1-inch
(2)	For any 2 successive intermediate points on the line or surface separated by:	
	10- to 20-feet, inclusive.....	Exposed: 3/8-inch Buried: 3/4-inch
	More than 20-feet .....	Exposed: 1/2-inch Buried: 1-inch
3.	Variation from plumb of pipe erected vertically in any length of 10-feet .....	±1/2-inch

## F. Surface irregularities:

1. Bulges, depressions, and offsets are defined as surface irregularities or roughness.
2. Surface irregularities are classified as “abrupt” or “gradual” and allowable tolerances are specified in Table 03 30 00D - Surface Tolerances:
  - a. A surface tolerance is designated by a capital “T” followed by a number 1 through 5.
  - b. Surface tolerance designations are separate from surface finishes and structural deviations.

3. Abrupt surface irregularities:
  - a. Abrupt surface irregularities are defined as offsets such as those caused by misplaced or loose forms in which maximum dimension of irregularity perpendicular to surface is greater than maximum dimension of irregularity in plane of surface.
  - b. Abrupt surface irregularities include isolated surface irregularities which exceed specified gradual irregularities.
4. Gradual surface irregularities:
  - a. Gradual surface irregularities are defined as bulges and depressions resulting in gradual changes on surface.
  - b. Gradual surface irregularities are further defined as isolated undulations on surface. Maximum dimension of undulation perpendicular to surface is small relative to maximum dimension of undulation in plane of surface.
5. Check magnitude of surface irregularities of formwork and finished surfaces to ensure that surfaces are within specified tolerances.

G. Surface tolerances:

Table 03 30 00D - Surface Tolerances

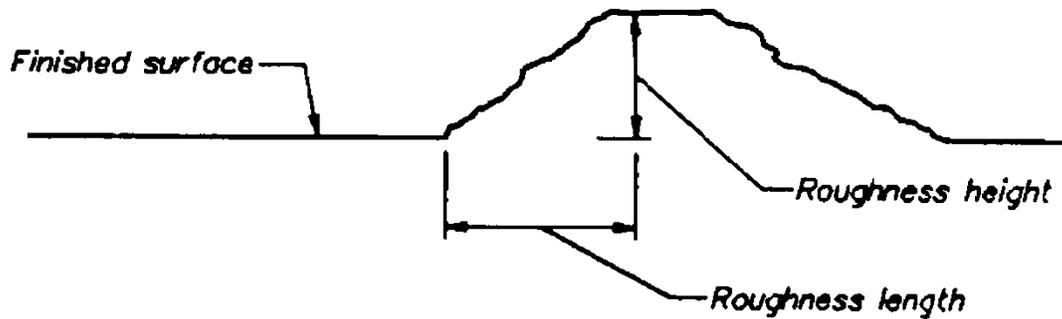
Concrete surface	Maximum allowable surface irregularity tolerance	
	Abrupt	Gradual
T1	1-inch	1/4-inch/inch
T2	1/2-inch	1/8-inch/inch
T3	1/4-inch	1/16-inch/inch
T4	1/8-inch	1/32-inch/inch
T5	1/32-inch	1/120-inch/inch

- H. Repair of hardened concrete not within specified tolerances:
1. Repair hardened concrete which is not within specified tolerances to bring it within those tolerances.
  2. Perform repair after consultation with Government inspector regarding method of repair. Notify COR as to time when repair will be performed.
  3. Repair concrete which will be exposed to view in manner which will result in concrete surface with uniform appearance:
    - a. When grinding surfaces exposed to view, limit depth of grinding such that no aggregate particles are exposed more than 1/16-inch in cross section at finished surface.

- b. Where grinding has caused or will cause exposure of aggregate particles greater than 1/16-inch in cross section at finished surface, repair concrete by excavating and replacing concrete.

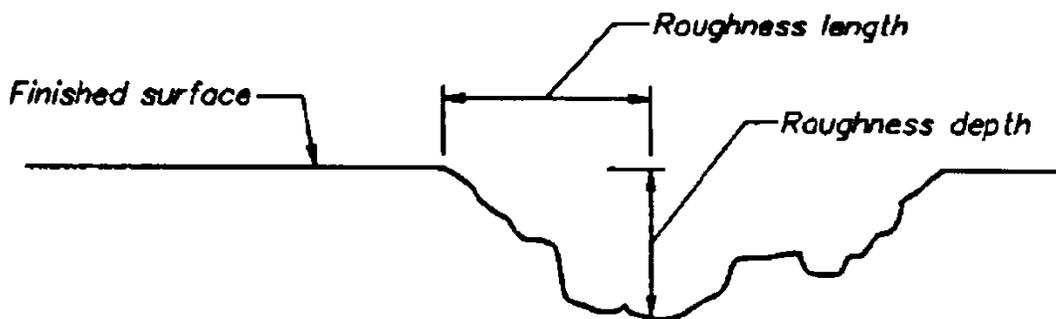
I. Field verification of surface tolerances:

1. Determine compliance of surface with specified surface tolerances.
2. Evaluate surface roughness:
  - a. Measure roughness height or depth and check for compliance with values specified in Table 03 30 00D - Surface Tolerances and Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions.
  - b. When measured height or depth of roughness is less than value in abrupt tolerance specification and height or depth of roughness does not cause structure to exceed applicable value specified in Table 03 30 00C - Deviations from Specified Lines, Grades, and Dimensions, surface roughness is acceptable.
  - c. When roughness height or depth exceeds abrupt tolerance specification, determine roughness slope for comparison to gradual tolerance specification:
    - 1) Measure roughness length and determine roughness slope by dividing roughness height or depth by roughness length (See Figure 1).
    - 2) When roughness slope is greater than slope specified by gradual tolerance specification, surface roughness is unacceptable.
    - 3) When roughness slope is less than gradual slope specified and gradual roughness does not cause structure to exceed allowable structural deviations, surface roughness is acceptable.



$$\text{Roughness slope ratio} = \frac{\text{Roughness height}}{\text{Roughness length}}$$

**CASE 1 = Offset on the Surface**



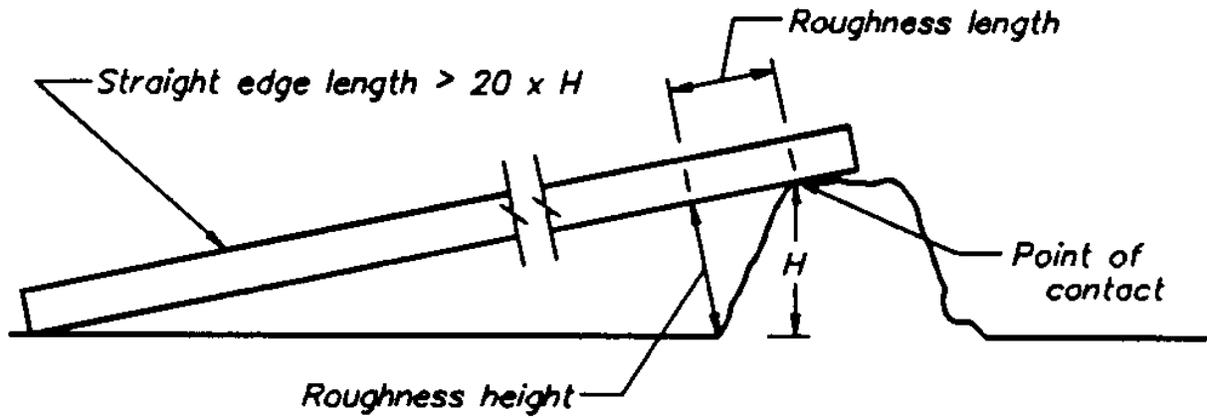
$$\text{Roughness slope ratio} = \frac{\text{Roughness depth}}{\text{Roughness length}}$$

**CASE 2 = Offset into the Surface**

**FIGURE 1**

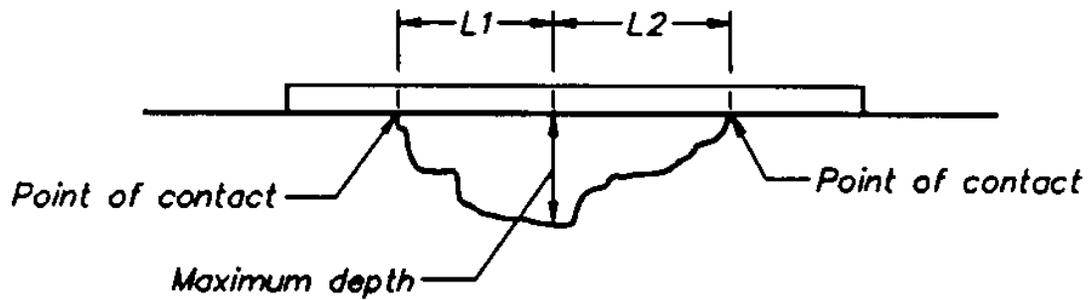
J. Measuring surface roughness:

1. Examples below illustrate how to make necessary surface measurements for typical roughness.
2. Case 1 - Roughness Protruding above Surface:
  - a. Measure roughness protruding above surface with straightedge that is at least 20 times longer than roughness height being measured.
  - b. Position straightedge with one end resting on top of roughness, as shown in Figure 2 (Case 1).
  - c. Determine roughness height by measuring maximum gap that occurs normal to straight edge.
  - d. Note position on the straightedge from which normal distance is measured.
  - e. To determine roughness length, measure distance along straightedge from point where the height was measured to point of contact between straightedge and top of roughness.
  - f. Roughness slope is defined as ratio of roughness height to roughness length.
  - g. As roughness is seldom symmetric, moving position of straightedge about roughness may be necessary to locate point where maximum height and slope exists.
3. Case 2 - Roughness Extending below the Surface:
  - a. A roughness occurring as an indentation to surface is measured by placing straightedge across indentation, as shown in Figure 2 (case 2).
  - b. Measure maximum gap between straightedge and surface and note location of measurement on straightedge.
  - c. From point of depth measurement, measure along straightedge in both directions to point of contact with surface.
  - d. Use shortest length measured as roughness length.
  - e. Divide roughness depth by roughness length to determine roughness slope.



CASE 1

$$\text{Roughness slope} = \frac{\text{Roughness depth}}{\text{The shortest distance } L1 \text{ or } L2}$$



CASE 2

FIGURE 2

- K. Prevention of repeated failure to meet tolerances:
1. When concrete placements result in hardened concrete which does not meet specified tolerances, submit to COR an outline of preventive actions such as modifications to forms, modified procedure for setting screeds, and different finishing techniques to be implemented to avoid repeated failures. Submit when requested by COR.
  2. Government reserves the right to delay concrete placements until preventive actions which have been approved by COR are implemented.

### **3.06 CURING**

A. Water Curing:

1. Keep concrete surface wet for 14-days, minimum, from time concrete has attained sufficient set to prevent detrimental effects to surface.
2. Cure methods:
  - a. Water-saturated material.
  - b. System of perforated pipes, mechanical sprinklers, or porous hose.
  - c. Other methods which will keep surfaces wet.
  - d. Subject to approval by COR.

B. Curing with Curing Compound:

1. Apply to concrete surface to provide water-retaining film. Reapply as necessary to maintain continuous, water-retaining film on surface for 28-days.
2. Thoroughly mix compound and spray apply in one coat to provide continuous, uniform film over surface.
3. Do not exceed coverage rate recommended by curing compound manufacturer. Decrease coverage rate on rough surfaces as necessary to obtain required continuous film.
4. Ensure ample coverage on edges, corners, and rough surfaces.
5. Use spray equipment recommended by curing compound manufacturer.

C. Sheet Material Curing:

1. Thoroughly moisten concrete surface by lightly spraying with water as soon as concrete has hardened sufficiently to prevent damage.
2. Completely cover concrete surface with sheet material to provide airtight, water-retaining film over entire surface.
3. Lap edges of sheet material to seal adjacent sheets.
4. Place tightly against concrete surface at extreme edge of curing area.

5. Secure sheet material to withstand wind and prevent circulation of air inside sheet material.
6. Keep surface covered for 14-days, minimum.

### 3.07 CONTRACTOR FIELD QUALITY TESTING

- A. Perform sampling, testing, and reporting as required in Table 03 30 00E - Field Testing:
  1. Independent testing agency shall meet requirements specified in Section 01 46 20 – Testing Agency Services.
  2. Personnel conducting plastic concrete field tests: Qualified as ACI Concrete Field-Testing Technician, Grade 1; or equal.
  3. Personnel conducting concrete specimen tests: Qualified as ACI Concrete Strength Testing Technician; or equal.
- B. Perform tests at least as often as frequencies specified in Table 03 30 00E - Field Testing.
- C. Notify COR immediately of test results showing failure of materials to meet specifications. Notify COR within 2-hours of test results showing materials meet specifications. Submit reports of test results as specified.

### 3.08 FIELD QUALITY ASSURANCE

- A. In addition to specified Contractor Quality Field Testing, Government may also perform tests listed in Table 03 30 00E – Field Testing.

Table 03 30 00E – Field Testing

TESTS OF	TEST STANDARD	STANDARD TITLE	TESTING FREQUENCY
Fresh Concrete Properties - tests performed at site	ASTM C143	Slump of Hydraulic-Cement Concrete	1 set of tests per load for first 2 loads.
	ASTM C231	Air Content of Freshly Mixed Concrete by the Pressure Method (alternative to ASTM C138 gravimetric method)	When tested concrete meets specifications, 1 set of tests each day of placement for each mixture for first 50 or less cubic yards, and 1 set of tests for each additional 100 cubic yards of concrete. Minimum of 1 set of tests per hour during placements. When concrete does not meet specifications, test each load until 2

Table 03 30 00E – Field Testing

TESTS OF	TEST STANDARD	STANDARD TITLE	TESTING FREQUENCY
	ASTM C1064	Temperature of Freshly Mixed Hydraulic-Cement Concrete	consecutive loads meet specifications, then resume testing frequency specified above.
	ASTM C138	Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete	
Compressive Strength,	ASTM C31  ASTM C39	Making and Curing Concrete Test Specimens in the Field  Compressive Strength of Cylindrical Concrete Specimens	<p>1 set of samples (6-inch by 12-inch for each day of placement for each mixture for the first 50 or less cubic yards, and 1 set of samples for each additional 100 cubic yards of concrete. A minimum of 5 samples for strength testing shall be made each time strength samples are collected.</p> <p>2 additional field cured test cylinders during placement in adverse (hot or cold) weather. Cure these samples on jobsite under same conditions as concrete the cylinders represent for minimum of 7-days, then transfer to testing laboratory until testing at strength design days.</p> <p>Test 2 cylinders each at 7-days age and 2 cylinders at strength design age. Maintain last cylinder for testing in event that the strength design age test results fall below the required strength.</p>

Table 03 30 00E – Field Testing

TESTS OF	TEST STANDARD	STANDARD TITLE	TESTING FREQUENCY
Concrete Cores	ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	<p>At discretion of Government when cylinder strengths fail to meet minimum requirements.</p> <p>Contractor shall obtain core specimens in accordance with ASTM C42 at locations directed by COR, at no additional cost to the Government. Contractor shall repair core holes in accordance with USBR M-47 as directed by COR</p>

B. Acceptance criteria:

1. Cylinder compressive strength:
  - a. In accordance with ASTM C94, except as follows:
    - 1) 90 percent of test cylinders exceed specified compressive strength at design age.
    - 2) Average compressive strength of six consecutive test cylinders exceeds specified compressive strength at design age.
    - 3) No individual strength test falls below specified compressive strength by more than 500 pounds per square inch.
2. Drilled concrete cores:
  - a. Concrete in placement represented by core tests will be considered structurally adequate when average compressive strength of three cores is equal to at least 85 percent of specified compressive strength and no single core has a compressive strength of less than 75 percent of specified compressive strength.

### 3.09 PROTECTION

A. Protect concrete from damage until final acceptance by Government:

1. Do not load, remove forms or shoring, or backfill against concrete until concrete has gained sufficient strength to safely support its weight and imposed loads.
2. Protect fresh concrete against erosion from rain, hail, sleet, or snow; contamination from foreign materials; and damage from foot traffic until the concrete has hardened.

3. Protect concrete from heavy foot traffic and other construction activities by covering with plywood or other suitable material. Remove and dispose of temporary covering when no longer required.
- B. Protect concrete when freezing temperatures are imminent:
1. Maintain concrete at a temperature of 50 degrees F (10 degrees C) or greater for 72-hours, minimum, after placement. Vent heater and prevent concrete from drying where artificial heat is employed.
  2. Protect concrete from freezing during water curing. After discontinuance of water curing, maintain at a temperature of 50 degrees F (10 degrees C) or greater for next 72-hours.
  3. Discontinue protection against cold weather such that the drop in temperature of the concrete will be gradual and will not exceed 5 degrees F per hour and 40 degrees F in 24-hours [for thin sections and 5 degrees F per hour and 20 degrees F in 24-hours for massive sections greater than 36-inches.

### 3.10 REPAIR

- A. Repair concrete in accordance with USBR M-47.
- B. Use repair or replacement method directed by COR.

### 3.11 FINISH, SURFACE TOLERANCES, AND CURING SCHEDULES

Table 03 30 00F – Formed Surfaces

Surface	Finish	Maximum Allowable Tolerances	Acceptable Curing Methods
Surfaces upon or against which fill material will be placed	F1	T1	Water, White ASTM C309 Class A or B curing compound for horizontal surfaces, and White ASTM C309, Class B curing compound for vertical or sloped surfaces.
Surfaces not permanently concealed by fill material or concrete where appearance is not critical	F2	T2 and T3	Water, White ASTM C309 Class A or B curing compound for horizontal surfaces, and White ASTM C309, Class B curing compound for vertical or sloped surfaces.

Table 03 30 00F – Formed Surfaces

Surface	Finish	Maximum Allowable Tolerances	Acceptable Curing Methods
Pedestals and equipment foundations	F2	T5	ASTM C1315 Class A Clear curing compounds, water-emulsified resin- base if outdoors, Polyethylene film

Table 03 30 00G - Unformed Surfaces

Surface	Finish	Maximum Allowable Tolerances	Acceptable Curing Methods
Surfaces to be covered by fill material or concrete	U1	T1	White ASTM C309 Class A or B curing compound for horizontal surfaces, and White ASTM C309, Class B curing compound for vertical or sloped surfaces
Outdoor equipment slabs and foundations	U2	T3	White ASTM C309 Class A or B curing compound, Polyethylene film or White Burlap-polyethylene sheet
Interior floor slabs for pumping plants, chemical building and turnout building	F3	T5	White ASTM C309 Class A or B curing compound, Polyethylene film or White Burlap-polyethylene sheet

**END OF SECTION**

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**SECTION 03 35 10**  
**CONCRETE FLOOR HARDENER**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Concrete Floor Hardener:
1. Measurement: Area of floor on which concrete floor hardener applied.
  2. Payment: Square foot price offered in the Price Schedules.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 03 35 10-1, Manufacturer's Instructions:
1. Rate of coverage and application procedures.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Commercial mixtures:
1. Lapidolith manufactured by Contech, Inc., Sonneborn Division of BASF, 889 Valley park Dr., Shakopee MN 55379, Flouhard manufactured by L&M Construction Chemicals, 14581 Calhoun Road, Omaha NE 68152, or Con-O-Lith manufactured by Conspec 636 S. 66<sup>th</sup> terrace, Kansas City, KS 66111; or equal with the following essential characteristics:
    - a. Contains magnesium fluosilicates, zinc fluosilicates, or sodium flousilicates individually or in combination with a wetting agent.
    - b. Colorless aqueous solution.

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. After concrete floors have thoroughly cured and at such time as approved by COR, clean concrete surfaces thoroughly of curing compound, dirt, grease, laitance, or other foreign matter as recommended by manufacturer.

### 3.02 APPLICATION

- A. Apply concrete floor hardener to the following areas:
  - 1. Pumping Plant No. 4 includes:
    - a. Pump and Air Chamber Rooms
    - b. ~~Chemical building floor.~~
  - 2. Pumping Plant No. 7 includes:
    - a. Pump and Air Chamber Rooms
- B. Apply three coats of floor hardener immediately after floors are dry from cleaning:
  - 1. Coverage rate and application procedures: As recommended by manufacturer of liquid floor hardener.
- C. Spread each coat of floor hardener uniformly.
- D. Prevent pools of hardener solution from appearing.
- E. Allow each coat to dry thoroughly before next coat is applied.
- F. After last coat has dried, brush floors and wash with water to remove crystals which may have formed on surface.

**END OF SECTION**



- B. ASTM International (ASTM)
1. ASTM A123/A123M-17 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  2. ASTM C31/C31M-19 Standard Practice for Making and Curing Concrete Test Specimens in the Field
  3. ASTM C33/C33M-18 Concrete Aggregates
  4. ASTM C39/C39M-18 Test Method for Compressive Strength of Cylindrical Concrete Specimens
  5. ASTM C138/C138M-17a Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
  6. ASTM C143/C143M-15a Test Method for Slump of Hydraulic-Cement Concrete
  7. ASTM C173/C173M-16 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
  8. ASTM C192/C192M-18 Practice for Making and Curing Concrete Test Specimens in the Laboratory
  9. ASTM C231/C231M-17a Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
  10. ASTM C443/C443M-19a Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
  11. ASTM C478-19 Circular Precast Reinforced Concrete Manhole Sections
  12. ASTM C497-19a Test Methods for Concrete Pipe, Manhole Sections, or Tile
  13. ASTM C857-19 Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
  14. ASTM C858-19 Underground Precast Concrete Utility Structures
  15. ASTM C877-16 External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
  16. ASTM C920-18 Elastomeric Joint Sealants
  17. ASTM C923-18 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
  18. ASTM C990-09(2019) Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
  19. ASTM C1064/C1064M-17 Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

- |     |                      |  |
|-----|----------------------|--|
| 20. | ASTM C1107/C1107M-17 | Packaged Dry, Hydraulic-Cement Grout (Nonshrink)   |
| 21. | ASTM C1478-19        | Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes, and Laterals |
| 22. | ASTM C1611/C1611-18  | Test Method for Slump Flow of Self-Consolidating Concrete  |
| 23. | ASTM D751-19         | Test Methods for Coated Fabrics  |
| 24. | ASTM D2136-19        | Test Method for Coated Fabrics – Low-Temperature Bend Test   |
- C. Code of Federal Regulations (CFR)
- |    |                |               |
|----|----------------|---------------|
| 1. | 29 CFR 1910.27 | Fixed Ladders |
|----|----------------|---------------|
- D. National Precast Concrete Association (NPCA)
- |    |                |  |
|----|----------------|--|
| 1. | NPCA QC Manual | Quality Control Manual for Precast Concrete Plants |
|----|----------------|--|

### **1.03 REFERENCE SPECIFICATION SECTIONS**

- A. 05 50 00 – Metal Fabrications
- B. 07 21 50 – Spray-Applied Polyurethane Foam Insulation
- C. 07 72 30 – Roof Hatches

### **1.04 SUBMITTALS**

- A. Submit the following in accordance with 01 33 00 – Submittals.
- B. RSN 03 48 00-1, Certificates:
  - 1. Submit quality control procedures established in accordance with NPCA Quality Control Manual for Precast Concrete Plants or verification of current NPCA Plant Certification.
- C. RSN 03 48 00-2, Shop Drawings:
  - 1. Standard Precast Concrete Unit Design:
    - a. Drawings for standard precast concrete units shall be shop drawings furnished by precast concrete producer for approval. Drawings shall demonstrate that applicable industry design standards have been met. Installation and construction information shall be included on shop drawings. Details of steel reinforcement size and placement as well as supporting design calculations, if appropriate, shall be included. Precast concrete units shall be produced in accordance with approved drawings. Drawings shall indicate assumptions used in design of standard units.

2. Non-Standard Precast Concrete Unit Design:
    - a. Drawings for custom-made precast concrete units shall be shop drawings furnished by precast concrete producer for approval. Drawings shall show complete design, installation, and construction information in such detail as to enable Government to determine adequacy of proposed units for intended purpose. Details of steel reinforcement size and placement as well as supporting design calculations, if appropriate, shall be included. Precast concrete units shall be produced in accordance with approved drawings.
- D. RSN 03 48 00-3, Product Data and Test Reports:
1. Standard Precast Concrete Units:
    - a. Standard precast concrete units, precast concrete producer shall supply cut sheets showing conformance to project drawings, requirements and to applicable industry design standards listed in this specification.
  2. Proprietary Precast Concrete Units:
    - a. Proprietary precast concrete units, precast concrete producer shall supply standard plans or informative literature. Supporting calculations and design details shall be available upon request. Precast concrete producer shall provide sufficient information as to demonstrate that such products will perform intended task.
  3. Anchorage, Lifting Inserts and Devices:
    - a. Anchors, lifting inserts and other devices, precast concrete producer shall provide product data sheets and proper installation instructions upon request. Precast concrete unit dimensions and safe working load shall be clearly indicated.
  4. Accessory Items:
    - a. Items including, but not limited to sealants, gaskets, pipe entry connectors, steps, racks and other items installed before or after delivery, precast concrete producer shall include proper installation instructions and relevant product data upon request.
  5. Design Data:
    - a. Upon request, precast concrete producer shall supply precast concrete unit design calculations and concrete mix design proportions and appropriate mix design test data. Structural design calculations shall be signed by licensed professional engineer registered in State of New Mexico.
  6. Test Reports:
    - a. Upon request, precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast-furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

- b. Upon request, precast concrete producer shall submit copies of test reports showing that mix has been successfully tested to produce concrete with properties specified and will be suitable for project conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze-thaw durability, abrasion and absorption. Special tests for precast concrete items shall be clearly detailed in the specifications.
- c. Upon request, precast concrete producer will supply copies of in-plant QA/QC inspection reports.

## **1.05 QUALIFICATIONS**

### **A. NPCA Plant Certification:**

- 1. Precast concrete producer shall be certified by NPCA Plant Certification Program prior to and during production of products for this project.

### **B. Qualifications, Quality Control and Inspection:**

#### **1. Qualifications:**

- a. Precast concrete producer shall have been in the business of producing precast concrete units similar to those specified for a minimum of 5-years. Precast concrete producer shall maintain permanent quality control department or retain an independent testing agency on continuing basis. Agency shall issue a report, signed by a licensed professional engineer registered in State of New Mexico, detailing ability of precast concrete producer to produce quality units consistent with industry standards.

#### **2. Quality Control:**

- a. Precast concrete producer shall show that the following quality control tests are performed as required and in accordance with ASTM International standards indicated:
  - 1) Slump: Slump test shall be performed for each 150 cu yd. of concrete produced per mix design, or once per day, whichever comes first. Slump tests shall be performed in accordance with ASTM C143. Slump flow tests on self-consolidating concrete mixes shall be performed in accordance with ASTM C1611.
  - 2) Temperature: Temperature of fresh concrete shall be measured when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C1064.
  - 3) Compressive Strength: At least four compressive strength specimens shall be made for each 150 cu yd. of concrete of each mix design in accordance with the following applicable ASTM standards; C31, C39, C192, and C497.

- 4) Air Content: Tests for air content shall be made on air-entrained, wet-cast concrete for each 150 cu yd. of concrete, per mix design, but not less often than once each day when air-entrained concrete is used. Air content shall be determined in accordance with either ASTM C231 or ASTM C173 for normal weight aggregates and ASTM C173 for lightweight aggregates.
  - 5) Density (Unit Weight): Tests for density shall be performed a minimum of once per week to verify yield of batch mixes. Density tests shall be performed for each 100 cu yd. of lightweight concrete in accordance with ASTM C138. Density tests shall be performed for each 100 cu yd. of concrete per mix design, but not less often than once per day when volumetric batch equipment is used.
- b. Inspection:
- 1) Government may place an inspector in plant when units covered by this specification are being manufactured. Precast concrete producer shall give notice of 14-days prior to time precast concrete units will be available for plant inspection.

## **1.06 DELIVERY, STORAGE AND HANDLING**

### **A. Delivery:**

1. Precast concrete units shall be delivered to site in accordance with delivery schedule to avoid excessive build-up of units in storage at site. Upon delivery to jobsite all precast concrete units shall be inspected by Government's representative for quality and final acceptance.

### **B. Storage:**

1. Precast concrete units shall be stored in a manner that will minimize potential damage.

### **C. Handling:**

1. Precast concrete units shall be handled and transported in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose as indicated on shop drawings. Upon request, precast concrete producer shall provide documentation on acceptable handling methods for product.

### **D. Final Acceptance:**

1. Upon final acceptance, Government acknowledges and understands appropriate methods for handling accepted precast concrete unit(s). Upon acceptance by Government, precast concrete manufacture is not responsible for replacing damaged product resulting from improper handling practices on jobsite.

## PART 2 PRODUCTS

### 2.01 SYSTEM DESCRIPTION

- A. Plan view showing locations of precast concrete vaults, manholes and pullboxes is provided on drawings 1695-D-60403 and 1695-D-60406 for Pumping Plant No. 4 and Pumping Plant No. 7, respectively.

Conceptual Layout	Type	Drawing No.
Flowmeter Vault	I	1695-D-60435
Flowmeter Vault	II	1695-D-60448
Flowmeter Vault	III	1695-D-60449
Manholes	I and II	1695-D-60436
Tank Overflow/Drain Vault		1695-D-60437
Utility Vault		1695-D-60438

### 2.02 DESIGN REQUIREMENTS:

- A. Standard Precast Concrete Unit Design:
- Contractor shall design standard precast concrete units (structure, covers and/or grating) to withstand HS 20-44 as defined in AASHTO SSHB and ASTM C857. Design must also consider stresses induced during handling, shipping and installation in order to avoid product cracking or other handling damage. Design loads for precast concrete units shall be indicated on shop drawings
  - Provide block-outs and pipe entry connectors as required.
- B. Non-Standard Precast Concrete Unit Design:
- Design calculations and drawings of non-standard precast units shall be prepared and signed by a licensed professional engineer registered in State of New Mexico and submitted for approval prior to fabrication. Calculations shall include the analysis of units for lifting stresses and sizing of lifting devices.
  - Provide block-outs and pipe entry connectors as required.
- C. Joints and Sealants:
- Joints and sealants between adjacent units shall be of type and configuration indicated on shop drawings meeting specified design and performance requirements.
- D. Quality Assurance:
- Precast concrete producer shall demonstrate adherence to standards set forth in NPCA Quality Control Manual for Precast Concrete Plants. Precast concrete producer shall meet requirements written in subparagraph 1.04.B.

## **2.03 MATERIALS**

### **A. Concrete and Reinforcement:**

1. Refer to ASTM C858.

### **B. Inserts and Embedded Metal:**

1. Refer to Section 05 50 00 – Metal Fabrications.
2. Proprietary Items:
  - a. In accordance with manufacturers published literature.

### **C. Joint Sealants and Joint Gaskets:**

1. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe:
  - a. ASTM C443.
2. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe:
  - a. ASTM C877.
3. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections:
  - a. ASTM C990.
4. Elastomeric Joint Sealants:
  - a. ASTM C920.

### **D. Pipe Entry Connectors:**

1. ASTM C923.
2. ASTM C1478.

### **E. Grout:**

1. Nonshrink Grout:
  - a. ASTM C1107.
2. Cementitious Grout:
  - a. Shall be of suitable mix design for intended use, consisting of portland cement, sand, and water.

## **2.04 PRECAST CONCRETE VAULT SECTIONS**

### **A. Precast concrete vault conforming to ASTM C858:**

1. Bell and spigot joints.
2. No elliptical reinforcement allowed.
3. Tank Overflow/Drain Vault shall be watertight.

- B. Joint Sealant: As recommended by manufacturer.
- C. Ladder Rungs:
  - 1. In accordance with 29 CFR 1910.27.
  - 2. Cast iron, galvanized steel, stainless steel, or polypropylene coated steel.
- D. Furnish precast concrete vaults for flowmeters and tank overflow/drain as shown on drawings.
- E. Furnish equivalent size precast concrete lids as shown on drawings.
- F. Furnish tank overflow/drain vault grating in accordance with Section 05 50 00 – Metal Fabrications.
- G. Furnish ladder safety posts in accordance with Section 05 50 00 – Metal Fabrications.
- H. Furnish roof hatches in accordance with Section 07 72 30 – Roof Hatches.

## **2.05 PRECAST CONCRETE MANHOLE SECTIONS**

- A. Concrete manhole and grade rings conforming to ASTM C478:
  - 1. Bell and spigot joints.
  - 2. No elliptical reinforcement allowed.
  - 3. Rubber gasket not required.
- B. Joint Sealant: As recommended by manufacturer.
- C. Ladder Rungs:
  - 1. In accordance with 29 CFR 1910.27.
  - 2. Cast iron, galvanized steel, stainless steel, or polypropylene coated steel.
- D. Furnish concrete manhole for manifold access as shown in drawings.
- E. Furnish equivalent size prefabricated lids as shown on drawings.
- F. Furnish pipe access manhole frames and covers in accordance with Section 05 50 00 – Metal Fabrications.
- G. Furnish ladder safety posts in accordance with Section 05 50 00 – Metal Fabrications.

## **2.06 PRECAST RECTANGULAR CONCRETE BLOWOFF ENCLOSURE**

- A. Concrete vault conforming to ASTM C858.
- B. Joint Sealant: As recommended by manufacturer.

- C. Furnish 4-foot 0-inch tall by 5-foot wide, by 3-foot long (inside dimensions), open bottom concrete enclosure for blowoff-pipe assembly access as shown in drawings.
- D. Furnish and install equivalent size, pedestrian rated, flush mounted cover.
- E. Hot-dipped galvanized steel cover sections fabricated from structural steel and steel plate with raised diamond pattern:
  - 1. Galvanizing: ASTM A123.
- F. Cover sections suitable for manual handling.

## **2.07 PRECAST RECTANGULAR CONCRETE PULLBOXES**

- A. Concrete vault conforming to ASTM C858.
- B. Joint Sealant: As recommended by manufacturer.
- C. Furnish 3-foot 6-inch tall by 4-foot wide, by 4-foot long (inside dimensions), open bottom concrete vault for chlorine system piping as shown in drawings.
- D. Furnish and install equivalent size, HS 20-44 traffic rated, flush mounted cover.
- E. Hot-dipped galvanized steel cover sections fabricated from structural steel and steel plate with raised diamond pattern:
  - 1. Galvanizing: ASTM A123.
- F. Cover sections suitable for manual handling.

## **2.08 BEDDING**

- A. ASTM C33, coarse aggregate, Size No. 57.

## **2.09 BATTEN SYSTEM**

- A. Furnish and install stainless steel anchors in accordance with Section 05 50 00 – Metal Fabrications.
- B. Furnish and install stainless steel plate in accordance with Section 05 50 00 – Metal Fabrications.
- C. Furnish and install reinforced polypropylene geomembrane, manufactured by Environmental Protection, Inc., [www.geomembrane.com](http://www.geomembrane.com) or equal with the following essential characteristics:
  - 1. Gauge, Nominal (ASTM D751): 36 +/- 10 percent mils
  - 2. Breaking Strength (ASTM D751, Method A: 250 x 200 pounds (lbs.).
  - 3. Tear Strength (ASTM D751): 100 lbs.

4. Low Temperature (ASTM D2136): -65 degrees F
5. Puncture Strength (FTMS-101 B, Method 2031): 250 lbs.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

#### **A. Site Access:**

1. Contractor shall be responsible for providing adequate access to site to facilitate hauling, storage and proper handling of precast concrete units.

#### **B. Installation:**

1. Precast concrete units shall be installed to lines and grades shown in contract documents or otherwise specified.
2. Place a minimum of 6-inches aggregate bedding below rectangular concrete pullboxes, in accordance with Section 31 23 02 – Compacting Earth Materials.
3. Precast concrete units shall be lifted by suitable lifting devices at points provided by precast concrete producer.
4. Precast concrete units shall be installed in accordance with applicable industry standards. Upon request, precast concrete producer shall provide installation instructions.
5. Field modifications to product shall relieve precast producer of liability regardless if such modifications result in failure of precast concrete unit.

#### **C. Watertightness:**

1. Where watertightness is a necessary performance characteristic of precast concrete units end use, watertight joints, pipe-entry connectors and inserts should be used to ensure integrity of entire system.

### **3.02 FIELD QUALITY CONTROL**

#### **A. Job Site Tests:**

1. When watertightness testing is required for precast concrete structure, the following method shall be followed by:
  - a. Hydrostatic Testing:
    - 1) Fill open top vault with water and let stand for 24-hours.
    - 2) Drain vault and refill. Vault is approved if water level is held for 1-hour. If test is unsuccessful, drain vault and fix any leaks and repeat steps 1) and 2) until successful.
    - 3) Drain vault.

**END OF SECTION**

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**SECTION 03 62 20**  
**NONSHRINK GROUT FOR EQUIPMENT AND METALWORK**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for items of work requiring nonshrink grout.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

1. ASTM C1107/C1107M-17                      Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 03 62 20-1, Packaged Nonshrink Grout Data:

1. Manufacturer's product data.
2. Manufacturer's certification that product meets specifications.
3. Manufacturer's instructions:
  - a. Surface preparation, mixing, installation, finishing, curing, and protection recommendations:
    - 1) Include specific recommendations based on anticipated jobsite temperatures and environmental conditions.
    - 2) Include manufacturer's recommended methods for float finishing grout.
    - 3) Include manufacturer's recommended minimum temperature and protection period for protecting grout from freezing and damage after placement.

**PART 2 PRODUCTS**

**2.01 PACKAGED NONSHRINK GROUT**

A. Pre-mixed commercial grout mixture:

1. ASTM C1107.

- B. Water:
  - 1. Clean.
  - 2. Free of detrimental quantities of silt, organic matters, salts, or other impurities.
  - 3. As recommended by grout manufacturer.
- C. Mix: In accordance with manufacturer's instructions to consistency recommended by manufacturer for application.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Clean and prepare base concrete surface to which nonshrink grout will be bonded in accordance with manufacturer's instructions or as directed by COR:
  - 1. Roughen surface.
  - 2. Remove dirt, laitance, loose or defective concrete, curing compound, coatings, and other foreign material.
  - 3. Wash with water.
- B. Lubricate concrete surface by washing with water immediately before placing nonshrink grout when delay occurs between washing and placing nonshrink grout.

### **3.02 PLACING**

- A. Place nonshrink grout in accordance with manufacturer's instructions to completely fill space to be grouted.
- B. Use forms, where required, to confine nonshrink grout.

### **3.03 CURING**

- A. Cure exposed surface of packaged nonshrink grout by method recommended by manufacturer.
- B. Do not apply loads sooner than 72-hours after placement and only after nonshrink grout has attained compressive strength of at least 3,000 lb/in<sup>2</sup>.

**END OF CONTENTS**

**SECTION 03 63 00**  
**EPOXY GROUT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for items requiring epoxy grout.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

1. ASTM C579-01(2012) Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes
2. ASTM C580-02(2012) Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing's, and Polymer Concretes
3. ASTM D638-14 Tensile Properties of Plastics
4. ASTM D696-16 Coefficient of Linear Thermal Expansion of Plastic Between minus 30 and 30 degrees C with a Vitreous Silica Dilatometer

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 03 63 00-1, Approval Data:

1. Grout manufacturer's product data.
2. Grout manufacturer's environmental, product storage, preparation, mixing, installation and curing instructions.

**1.04 DELIVERY, STORAGE, AND HANDLING**

A. Deliver epoxy materials to jobsite in manufacturer's original unopened packaging with labels and seals intact.

B. Store epoxy materials in protected area in accordance with manufacturer's instructions.

## **PART 2 PRODUCTS**

### **2.01 EPOXY GROUT**

- A. Three part flowable epoxy grout; resin, hardener, and aggregate filler:
  - 1. CHOCKFAST RED manufactured by ITW Polymer Technologies, 130 Commerce Drive, Montgomery PA; or equal, having following essential characteristics:
    - a. ASTM C579 Compressive Strength: Minimum of 15,000 psi.
    - b. ASTM C579 Compressive Modulus: 2,000,000 psi.
    - c. ASTM D696 Coefficient of Linear Thermal Expansion:
      - 1)  $11.2 \times 10^{-6}$  degrees F.
    - d. ASTM C580 Flexural Strength: Minimum 4,000 psi.
    - e. ASTM D638 Tensile Strength: Minimum 1,800 psi.
    - f. Service temperature: Up to 140 degrees F.
    - g. Pot life: Approximately 3-hours at 70 degrees F.
    - h. Shelf life: 2-years in dry storage.
- B. Aggregate filler as recommended by manufacturer.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Mix and install grout in accordance with manufacturer's instructions to fill space to be grouted:
  - 1. Concrete shall be a minimum of 28-days old.
  - 2. Clean and roughen concrete surfaces.
  - 3. Remove dirt, dust, oil, grease, debris, paint, curing compounds, sealers, and unsound concrete.
  - 4. Mechanically prepare concrete surfaces in accordance with manufacturer's instructions to give surface profile of a minimum of 1/8-inch and expose coarse aggregate of concrete.
  - 5. Concrete shall have an open surface texture.
- B. Placement:
  - 1. Place grout at air temperature recommended by manufacturer.
  - 2. Bring materials to be epoxied as close to 70 degrees F as possible.
  - 3. Do not place grout over frozen concrete.

4. Hold grout in place with forms. Prepare forms to prevent sticking of grout.
  5. Minimum 3/4-inch by 3/4-inch, 45 degree chamfer.
  6. Mix grout components in accordance with manufacturer's instructions and technical data sheet.
  7. Place grout in accordance with manufacturer's instructions.
  8. Finish surface of grout in accordance with manufacturer's instructions.
  9. Smooth sharp edges.
- C. Protection:
1. Protect placed grout from damage during construction.
  2. Maintain grout at 50 degrees F or greater for 72-hours, minimum, after placement unless otherwise recommended by manufacturer:
    - a. After protection period, discontinue protection against cold weather such that the drop in temperature of the grout will be gradual and will not exceed 5 degrees F per hour and 40 degrees F in 24-hours.
  3. The more stringent of grout manufacturer's recommendation or section shall apply.
  4. Initial Loading:
    - a. Do not apply loads to epoxy grout sooner than 72-hours after placement:
      - 1) Apply load after epoxy grout has attained a compressive strength of 3,000 psi, minimum.
    - b. Time required for epoxy grout used to attain this strength will be determined by COR.
    - c. Take care when applying loads on hardened epoxy grout.
    - d. Contractor shall be responsible for damage resulting from impact loads when positioning equipment or metalwork.
- D. Protect from movement until grout has fully cured.

**END OF SECTION**

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**SECTION 04 22 10**  
**REINFORCED CONCRETE UNIT MASONRY ASSEMBLIES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Reinforced Concrete Unit Masonry Assemblies:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |     |                       |   |
|-----|-----------------------|---|
| 1.  | ASTM A153/A153M-16a   | Zinc Coating (Hot-Dip) on Iron and Steel Hardware                                 |
| 2.  | ASTM A615/A615M-18e1  | Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement                   |
| 3.  | ASTM A951/A951M-16e1  | Steel Wire for Masonry Joint Reinforcement  |
| 4.  | ASTM A1064/A1064M-18a | Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| 5.  | ASTM C90-16a          | Loadbearing Concrete Masonry Units  |
| 6.  | ASTM C140/C140M-18a   | Sampling and Testing Concrete Masonry Units and Related Units                     |
| 7.  | ASTM C144-18          | Aggregate for Masonry Mortar  |
| 8.  | ASTM C150/C150M-19a   | Portland Cement   |
| 9.  | ASTM C207-18          | Hydrated Lime for Masonry Purposes  |
| 10. | ASTM C270-19ae1       | Mortar for Unit Masonry   |
| 11. | ASTM C404-18          | Aggregates for Masonry Grout  |
| 12. | ASTM C426-16          | Linear Drying Shrinkage of Concrete Masonry Units                                 |
| 13. | ASTM C476-18          | Grout for Masonry   |

B. International Code Council (ICC)

- |    |     |                                  |
|----|-----|----------------------------------|
| 1. | IBC | 2015 International Building Code |
|----|-----|----------------------------------|

C. Masonry Industry Council (MIC)

- |    |            |  |
|----|------------|--|
| 1. | MIC Manual | Hot and Cold Weather Masonry Construction Manual, 1999 |
|----|------------|--|

2. Maintain copy of MIC Manual at jobsite during work.

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 04 22 10-1, Approval Data:
  1. Manufacturer's product data for each masonry unit, joint reinforcement, and accessory material:
    - a. Include test results which show minimum compressive strength and maximum water absorption for masonry units.
- C. RSN 04 22 10-2, Sample Kit:
  1. Manufacturer's color sample kit for color selection.
  2. Coordinate Reinforced Concrete Unit Masonry Assemblies color and texture selection with Sections 07 41 13 – Preinsulated Roof Panels, 07 42 13 – Preinsulated Metal Wall Panels, 07 72 30 – Roof Hatches, and 08 33 20 – Roll-Up Doors.
- D. RSN 04 22 10-3, Certifications:
  1. Manufacturer's certification that masonry units meet specified requirements. Attach results from specified source sampling and testing to each certification.
  2. Manufacturer's certification that portland cement and lime meet specified requirements.
- E. RSN 04 22 10-4, Mix Design:
  1. Mortar mix design indicating type and proportions of ingredients in compliance with proportion specifications of ASTM C270.
  2. Grout mix design indicating type and proportions of ingredients in compliance with proportion specifications of ASTM C476.
- F. RSN 04 22 10-5, Instructions:
  1. Manufacturer's instructions for cleaning masonry units.

### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials off ground and under cover to prevent contact with moisture.

### **1.05 AMBIENT CONDITONS**

- A. Comply with recommended practices of MIC Manual for hot and cold weather masonry.

## **PART 2 PRODUCTS**

### **2.01 MASONRY UNITS**

- A. ASTM C90, lightweight, hollow and solid units:
  - 1. Includes:
    - a. Wall blocks.
    - b. Wall caps.
- B. Finish: As indicated on drawings.
- C. Nominal Size:
  - 1. As indicated on drawings.
  - 2. Furnish necessary shapes and sizes, bond-beam units, lintel units, and corner units as required to satisfy conditions indicated on drawings. Include half-size units where required.
- D. Color: Selected by Government from manufacturers standard chart in accordance with Samples and Colors Submittals Article in Section 01 33 00 – Submittals.

### **2.02 MORTAR MATERIALS**

- A. Portland cement: ASTM C150; Type I, II, or III; standard gray color.
- B. Hydrated Lime: ASTM C207, Type N.
- C. Aggregate: ASTM C144.
- D. Water: Clean water free of detrimental amounts of silt, organic matter, alkali, salts, and other impurities.
- E. Color: Selected by Government from manufacturers standard chart in accordance with Samples and Colors Submittals Article in Section 01 33 00 – Submittals.

### **2.03 GROUT MATERIALS**

- A. Portland cement: ASTM C150; Type I, II, or III.
- B. Aggregate: ASTM C404.
- C. Water: Clean water free of detrimental amounts of silt, organic matter, alkali, salts, and other impurities.

## **2.04 REINFORCEMENTS**

### **A. Joint Reinforcements:**

1. ASTM A951, Ladder Type, with deformed longitudinal wires butt welded to cross wires at 16-inch intervals.
2. Material: ASTM A82 steel wire.
3. Wire size: No. 9 gage longitudinal and cross wires.
4. Finish: ASTM A153, Class B-2, hot-dipped zinc coating applied after fabrication.
5. Width: 2-inches less than nominal wall thickness.
6. Provide prefabricated corner and tee sections at wall corners and intersections.

### **B. Reinforcing Bars: ASTM A615, Grade 60, deformed steel bar, uncoated.**

## **2.05 CONTRACTOR SOURCE QUALITY TESTING**

- A. Sample and test masonry units in accordance with ASTM C140 and ASTM C426 before shipment to jobsite.

## **2.06 MORTAR MIX**

- A. Type: ASTM C270, Type N, proportion specification using specified materials.
- B. Do not add calcium chloride or anti-freeze compounds.
- C. Re-temper mortar in accordance with ASTM C270 except use and place mortar within 1 1/2-hours after mixing.

## **2.07 GROUT MIX**

- A. Coarse Grout: ASTM C476, proportion specification using specified materials.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Clean and roughen concrete substrate surfaces to be in contact with mortar or grout. Remove curing compounds, laitance, efflorescence, loose or defective concrete, sand, dirt, and foreign material.
- B. Clean top of unfinished masonry of loose mortar and foreign material before resuming work.
- C. Lay concrete masonry units dry. Do not pre-wet.
- D. Clean excess concrete and loose rust from dowel bars to be embedded in masonry.

- E. Clean loose rust and coatings from reinforcing bars, joint reinforcements, and metal items to be embedded in masonry.

### **3.02 COURSING**

- A. Place masonry plumb, level, and true to required lines.
- B. Maintain masonry courses to uniform width.
- C. Make vertical and horizontal joints equal and of uniform thickness.
- D. Lay units in running bond except as indicated on drawings. Course one unit and one mortar joint to equal nominal unit dimension.
- E. Form concave mortar joints.

### **3.03 PLACING AND BONDING**

- A. Lay masonry with completely filled mortar joints. Buttering corners of joints and deep or excessive furrowing of mortar joints are not permitted.
- B. Do not shift or tap units after mortar has taken initial set. Remove and replace with fresh mortar where adjustment must be made.
- C. Keep concrete foundation surfaces to be in contact with grout free of mortar.
- D. Keep cells to be grouted free of mortar.
- E. Keep wall cavities free of mortar.
- F. Remove excess mortar.
- G. Saw cut to form straight unchipped edges where jobsite cutting is required. Cut units dry.

### **3.04 TOLERANCES**

- A. Variation from unit to adjacent unit: 1/32-inch, maximum.
- B. Variation from plane of wall: 1/4-inch in 10-feet and 1/2-inch in 20-feet or more.
- C. Variation from plumb: 1/4-inch per story noncumulative, 1/2-inch in two stories or more.
- D. Variation from level coursing: 1/8-inch in 3-feet; 1/4-inch in 10-feet; 1/2-inch, maximum.
- E. Variation of joint thickness: 1/8-inch in 3-feet.
- F. Maximum variation from cross sectional thickness of walls: Plus or minus 1/4-inch.

### **3.05 REINFORCEMENT INSTALLATION**

- A. Joint Reinforcements:
  - 1. Place so that longitudinal wires are fully embedded in mortar.
  - 2. Lap ends 6-inch, minimum, at joints between reinforcement sections.
- B. Reinforcing Bars:
  - 1. Place reinforcing bars supported and secured against displacement.
  - 2. Maintain position within 1/2-inch of true dimension.
  - 3. Lap bar splices 48 bar diameters, minimum.

### **3.06 GROUTING**

- A. Place and consolidate grout fill without disturbing reinforcements.
- B. Maintain grout thickness of 1/2-inch, minimum, between bar and masonry units.
- C. Place grout in lifts of 4-foot, maximum, as wall is built.
- D. Stop grout 1 1/2-inches below top of masonry when grouting is stopped for 1-hour or more.
- E. Agitate to consolidate grout and fill space.
- F. Grout all reinforced masonry cells.
- G. Grout unreinforced masonry cells as indicated on drawings.

### **3.07 BUILT-IN WORK**

- A. Build in steel doorframes and other built-in items.
- B. Build in items plumb and level.
- C. Bed doorframe anchors in mortar joints.
- D. Fill doorframes solid with mortar.
- E. Rake joint between doorframes and masonry to 1/4-inch depth for sealant installation.

### **3.08 CUTTING AND FITTING**

- A. Cut and fit for pipes, conduits, sleeves, and similar items. Provide correct size, shape, and location.

**3.09 POINTING AND CLEANING**

- A. Cut out and replace defective mortar. Match adjacent work.
- B. Remove excess mortar and mortar and grout smears.
- C. Clean soiled surfaces.
- D. Clean masonry in accordance with manufacturer's instructions. Do not mottle, discolor, stain, damage, or acid burn masonry.
- E. Obtain approval of each cleaning method from COR at jobsite before using method on work.

**3.10 PROTECTION**

- A. Provide temporary bracing during erection to support finished work and withstand wind loads. Maintain bracing until structure provides permanent support.
- B. At workday's end, cover unfinished work with secure waterproof covers to prevent moisture infiltration. Keep unfinished work covered during work shutdown.

**3.11 CONTRACTOR FIELD QUALITY TESTING**

- A. Complete Level B Quality Assurance special inspection of masonry wall construction that is in compliance with International Building Code Sections 1704 through 1708. Reference drawings 1695-D-60401 and 1695-D-60402.

**END OF SECTION**

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**SECTION 05 21 00**  
**STEEL JOISTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Steel Joists:

1. Payment: Lump sum prices offered in Price Schedules.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |                           |   |
|----|---------------------------|---|
| 1. | ASTM A36-19               | Carbon Structural Steel   |
| 2. | ASTM A108-18              | Steel bar, Carbon and Alloy, Cold-Finished  |
| 3. | ASTM A123/A123M-17        | Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products                                 |
| 4. | ASTM A153/A 153M-16a      | Zinc Coating (Hot-Dip) on Iron and Steel Hardware   |
| 5. | ASTM A307-14e1            | Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength                       |
| 6. | ASTM F3125/F3125M-18      | High Strength Structural Bolts, Steel, Heat Treated, 120 and 150 ksi Minimum Tensile Strength |
| 7. | ASTM A563-15              | Carbon and Alloy Steel Nuts   |
| 8. | ASTM A780/A 780M-09(2015) | Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings                           |
| 9. | ASTM F436-18a             | Hardened Steel Washers  |

B. American Welding Society, Inc. (AWS)

- |    |                   |                                       |
|----|-------------------|---------------------------------------|
| 1. | AWS D1.1/D1.1M-15 | Structural Welding Code – Steel       |
| 2. | AWS D1.3/D1.3M-18 | Structural Welding Code – Sheet Steel |

C. Society for Protective Coatings (SSPC)/NACE International (NACE)

- |    |                     |                           |
|----|---------------------|---------------------------|
| 1. | SSPC-SP 6/NACE 3-06 | Commercial Blast Cleaning |
| 2. | SSPC-SP 7/NACE 4-15 | Brush-Off Blast Cleaning  |

- D. Steel Joist Institute (SJI)
  - 1. Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders, 43rd Edition
  - 2. Standard Specifications for Open Web Steel Joists, K-Series
  - 3. Technical Digest No. 8, “Welding of Open-web Steel Joists and Joist Girders”

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 05 21 00-1, Approval Drawings and Data:
  - 1. Manufacturer’s product for each distinct type of joist accessories, and product specified.
  - 2. Detailed shop and erection drawings:
    - a. Show layout of joist units, anchorage details, splice and connection details, bracing, bridging, accessories, and attachments to other work. Include mark, number, type, location and spacing of joists and bridging:
      - 1) Indicate locations and details of anchorage devices and bearing plates to be embedded in other construction.
  - 3. Manufacturer’s certification that joists comply with SJI “Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders.”
- C. RSN 05 21 00-2, Welder Qualifications:
  - 1. Provide certification that welders to be employed in work comply with requirements specified in Quality article.
  - 2. Provide written welding procedure specification (WPS) document per AWS Code requirements.
- D. RSN 05 21 00-3, Inspection Reports.

### **1.04 QUALITY**

- A. Manufacturer Qualification: Manufacturer shall be member of Steel Joist Institute.
- B. SJI Design Standard: Comply with recommendations of SJI’s “Standard Specification Load Tables and Weight Tables for Steel Joists and Joist Girders,” applicable to types of joists indicated.
- C. Welder qualification: Welders shall be certified in accordance with AWS D1.1 and D1.3 within the last 12-months. All welding shall comply with applicable provisions of AWS D1.1 and D1.3. Maintain permanent records of all pertinent information.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to site at such intervals to ensure uninterrupted progress of work. Inspect joists for damage before unloading and note any permanent bend, deformation or broken welds on receiving documents.
- B. Store materials to permit easy access for inspection and identification. Keep joist members off ground using pallets, skids, platforms or other supports.
- C. Protect steel members from corrosion and damage.
- D. Store packaged materials in original unbroken package or container.
- E. Do not store materials on structure in manner that might cause distortion or damage to members or supporting structures.
- F. Replace damaged shapes or members as required.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Steel: Comply with requirements of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders” and “Standard Specifications for Open Web Steel Joists, K-Series”.
- B. Welding Electrodes: Comply with AWS D1.1 and D1.3.

### **2.02 FABRICATION**

- A. Manufacture steel joists of type indicated in accordance with SJI specification. All material shall be clean and straight.
- B. Steel Joist Substitutes: Manufacture according to “Standard Specifications for Open Web Steel Joists, K-Series” with steel-angle or steel-channel members.
- C. Comply with AWS D1.1 and D1.3 requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
- D. Bridging: Provide horizontal or diagonal type bridging as required by “Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders” or as indicated on drawings for type of joist, chord size, spacing and span.
- E. Top Chord Extensions: Provide top chord extensions on joists as indicated on drawings. Extensions shall be capable of withstanding full uniform load of joist. Extensions shall be attached to embedded anchor plates as indicated on drawings.
- F. End Anchorage: Embedded anchor plates shall be used to secure joist to supports as indicated on drawings.

## 2.03 ACCESSORIES

- A. Bridging: Schematically indicated. Detail and fabricate according to SJI Specifications. Furnish additional erection bridging if required for stability.
- B. Provide accessories, including splice plates, reinforcing angles and bolts as required to complete joist installation while complying with SJI Specifications and Drawings.
- C. Threaded Fasteners: ASTM A307, Grade A, Galvanized.
- D. High-Strength Bolts: ASTM F3125:
  - 1. Heavy hex head: ASTM A325 Galvanized.
- E. Nuts: ASTM A563, Galvanized.
- F. Washers: ASTM F436, Galvanized.
- G. Embedded Anchor Plates
  - 1. Fabricated Plates: ASTM A36 steel, galvanized.
  - 2. Headed Concrete Anchors: H4L headed concrete anchor as manufactured by Nelson Stud Welding, Incorporated, 9008 S. Thomas Avenue, Bridgeview, IL 60455; or equal, having the following essential characteristics:
    - a. ASTM A108.
    - b. Flux-filled ends suitable for end welding to steel with automatically timed stud welding equipment.

## 2.04 GALVANIZING

- A. Cleaning:
  - 1. After shopwork completion, clean materials of rust, loose scale, dirt, oil, grease, slag from welded areas, and other foreign substances.
  - 2. Clean surfaces of metalwork in contact with or embedded in concrete or grouting mortar in accordance with SSPC-SP6/NACE 3 and SSPC-SP7/NACE 4.
- B. Steel Joists:
  - 1. Galvanize steel joists as designated on drawings for galvanizing.
  - 2. After cleaning, zinc coat materials in accordance with ASTM A123.
  - 3. Where member lengths prevent dipping in one operation, exercise care to prevent warping.
  - 4. Provide finished compression members with lateral variations not greater than 1/1000 axial length between points which are to be supported laterally.
  - 5. After galvanizing, remove excess spelter from holes.

- C. Hardware:
  - 1. Galvanize threaded fasteners, high-strength bolts, nuts, and washers in accordance with ASTM A153:
    - a. Remove excess spelter by centrifugal spinning.
- D. Embedded Anchor Plates:
  - 1. Galvanize items of metalwork as specified or shown on drawings. Use hot-dip galvanizing, where required after fabrication, in accordance with ASTM A123 and ASTM A385.
- E. Fabricator's Galvanizing Repair:
  - 1. Re-dip material with damaged galvanizing unless damage is local and can be repaired by two component epoxy zinc primer.
  - 2. If galvanized coating becomes damaged after being dipped twice, material will be rejected.
  - 3. Where local repair is authorized:
    - a. Repair damage to galvanizing, including damage due to drifting, repair operations, in accordance with Section 09 96 20 – Coatings.

## **2.05 INSPECTIONS AND TESTS**

- A. Joist manufacturer shall inspect in accordance with SJI Standard Specifications.
- B. Materials, fabrication, and welds may be visually inspected by Government in manufacturer's factory. Government may perform additional inspections and non-destructive tests on work questionable or suspect.
- C. Contractor shall bear cost for Government's inspection and tests, if such inspections and tests reveal failure of portions of the work to comply with requirements indicated in these Specifications. Contractor shall bear costs made necessary by such failures including those of repeated testing and inspections.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Prior to installation of steel joists and accessories:
  - 1. Examine supporting substrates, embedded bearing plates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of joists:
    - a. Verify all elevation locations and dimensions of surfaces to receive steel joist.
    - b. Furnish plates, angles and other accessories as required to secure joists.
    - c. Do not proceed with installation until unsatisfactory conditions have been corrected.

- B. Erection:
1. Place and secure steel joists in accordance with SJI Specifications, approved shop drawings.
  2. Placing joists: Do not place steel joists until supporting work is in place and secured. Place joists on supporting work, adjust and align in accurate locations and spacing before permanently fastening.
  3. Bridging: Install bridging simultaneously with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams. Comply with OSHA requirements for bolted bridging to be in place before slackening lines on joist longer than 40-feet.
  4. Fastening joists: Field weld joists to embedded anchor plates in accordance with SJI Specifications for type of joists used:
    - a. Comply with AWS requirements and procedures for welding, appearance and quality of welds and methods used in correcting welding work.
    - b. Coordinate welding sequence and procedure with placement of joists.
    - c. Lengths of welds applied to top and bottom chords of joist shall not exceed half the width of the member.
  5. Repair damaged galvanized coatings on exposed surfaces in accordance with Section 09 96 20 – Coatings.

### **3.02 REPAIRS**

- A. Repair damage as directed by COR.

**END OF SECTION**

**SECTION 05 30 00**  
**METAL ROOF DECK**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Metal Roof Deck:

1. Payment: Lump sum price offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American Institute of Steel Construction (AISC)

1. AISC 325-11 Steel Construction Manual, 14th Edition

B. American Institute and Steel Institute (AISI)

1. AISI S100-16 North American Specification for the Design of Cold-Formed Steel Structural Members

C. ASTM International (ASTM)

1. ASTM A 653/A653M-19a Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process
2. ASTM A 780/A 780M-09(2015) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
3. ASTM A 924/A 924M-19 General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
4. ASTM A 1008/A 1008M-18 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

D. American Welding Society, Inc. (AWS)

1. AWS D1.1/D1.1M-115 Structural Welding Code - Steel
2. AWS D1.3/D1.3M-18 Structural Welding Code - Sheet Steel

E. Steel Deck Institute (SDI)

1. SDI 31-2013 Design Manual for Composite Decks, Form Decks and Roof Decks

## 2. SDI MOC2-2016

## Manual of Construction with Steel Deck

**1.03 PERFORMANCE REQUIREMENTS**

- A. Design the attachment of metal roof deck to roof framing according to SDI 33 as required and per manufacturer's recommendations.
- B. Structural Performance: Design the metal roof deck attachment to withstand specified design loads within and under conditions required:
  - 1. Design loads: As specified on drawings.

**1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 05 30 00-1, Approval Drawings and Data:
  - 1. Metal deck manufacturer's product data:
    - a. Include complete descriptions of, specifications and installation instructions for the roof metal deck, and accessories. Include material type, grade, metal thickness, and finish.
  - 2. Detailed shop and erection drawings:
    - a. Show deck section layout and attachment to steel roof joists and structural steel, including unit dimensions and sections.
    - b. Show type and number of deck units and type, location and method of attachment.
    - c. Show all accessories and details required for proper installation of metal roof decks as specified on drawings.
- C. RSN 05 30 00-2, Welder Qualifications:
  - 1. Welder's and tacker's identification and qualifications.

**1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Member of Steel Deck Institute.
- B. Welder Qualifications: Qualify in accordance with AWS D1.1 and D1.3. Maintain permanent records of all pertinent information.
- C. Visually inspect all puddle welds.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store and handle metal roof deck in manner to protect from corrosion, deformation, and other types of damage.

- B. Do not bend metal roof decking. Exercise care not to damage material or overload decking during construction period.
- C. Maximum uniform distributed storage load shall not exceed design live load.
- D. Stack decking on platforms or pallets and cover with watertight ventilated covering. Elevate one end during storage to provide for drainage. Always Maintain deck finish to prevent formation of rust.
- E. Replace damaged material.

## **PART 2 PRODUCTS**

### **2.01 METAL ROOF DECK**

- A. 1.5B22 Metal deck manufactured by Vulcraft, 1875 West Highway 13 South, Brigham City, UT 84302, Telephone: 435-734-9433; or equal, having the following essential characteristics:
  - 1. Conform to SDI 31 and SDI DDM03.
  - 2. Nominal depth: 1.5-inches.
  - 3. Thickness before coating: 22 gage nominal, 0.0295-inches, minimum.
  - 4. Section modulus: 0.186 in<sup>3</sup>/ft, minimum.
  - 5. Moment of inertia: 0.155 in<sup>4</sup>/ft, minimum.
  - 6. ASTM A 1008, Grades C and D, or ASTM A 653, Structural Quality:
    - a. Yield Strength: 33,000 pounds per square inch, minimum.
  - 7. Steel Materials Content:
    - a. If manufactured in Basic Oxygen Furnace:
      - 1) Minimum post-consumer content: 16 percent.
      - 2) Minimum total recovered materials: 25 to 30 percent.
    - b. If manufactured in Electric Arc Furnace:
      - 1) Minimum post-consumer content: 67 percent.
      - 2) Minimum total recovered materials: 100 percent.
  - 8. Metal deck shall be galvanized:
    - a. Galvanizing shall conform to ASTM A924 with minimum coating class of G30 as defined in ASTM A653.
  - 9. Panel Length: To span from end support to end support.

## **2.02 ACCESSORIES**

- A. Provide accessories required for fastening and finished installation of metal deck in accordance with SDI 31 and SDI MOC2.
- B. Accessories shall be galvanized.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Prior to installation of decking units and accessories, examine worksite to verify structure will permit installation of decking system without modification and supporting members are in correct layout and alignment.

### **3.02 PREPARATION**

- A. Check surfaces to receive decking and assure they are free of debris.

### **3.03 INSTALLATION**

- A. Install steel deck units and accessories in accordance with approved shop drawings, SDI MOC2, and manufacturer's recommendations.
- B. Place units on structural supports, properly adjusted, leveled, aligned side laps, and aligned at right angles to supports.
- C. Align steel deck units before permanently anchoring. Locate deck ends over supports only.
- D. Bearing Length: 2 1/2-inches, minimum.
- E. Attachment: Immediately after placement and alignment, and after correcting inaccuracies, permanently fasten metal deck units to structural supports and to adjacent deck units as shown on shop drawings:
  - 1. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing welding.
  - 2. Attachment of adjacent deck units by button-punching is prohibited.
  - 3. Location, size, and spacing of fastening shall be as indicated on approved shop drawings.
- F. Welding: Perform welding in accordance with AWS D1.3 using methods and electrodes recommended by manufacturer of base metal alloys being used:
  - 1. Ensure only operators previously qualified by tests prescribed in AWS D1.1 and AWS D1.3 perform welds.

2. Immediately clean welds by chipping and wire brushing.
  3. Heavily coat welds, cut edges and damaged portions of coated finish in accordance with section 09 96 20 – Coatings.
- G. Cutting and Fitting: Cut and fit deck units and accessories around projections through roof with neat, square, and trim cuts. Do not use cutting torches where neat appearance is required.

### **3.04 REPAIRS**

- A. Repair damaged galvanized coatings on exposed surfaces in accordance with Section 09 96 20 – Coatings.
- B. Repair damage as directed by COR.

**END OF SECTION**

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**SECTION 05 40 00**  
**COLD-FORMED METAL FRAMING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. American Iron and Steel Institute (AISI)

1. AISI S100-12 North American Specification for the Design of Cold-Formed Steel Structural Members

B. ASTM International (ASTM)

1. ASTM A36/A36M-14 Carbon Structural Steel
2. ASTM A123/A123M-17 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
3. ASTM A153/A153M-16a Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. ASTM A307-14e1 Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
5. ASTM A653/A653M-17 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
6. ASTM C645-14e1 Nonstructural Steel Framing Members
7. ASTM C754-17 Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
8. ASTM C955-17 Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases
9. ASTM E488/E488M-15 Strength of Anchors in Concrete Elements
10. ASTM E1190-11 Strength of Power-Actuated Fasteners Installed in Structural Members

C. American Welding Society (AWS)

- |                                     |                   |  |
|-------------------------------------|-------------------|--|
| 1.                                  | AWS A2.4-12       | Standard Symbols for Welding, Brazing,<br>and Nondestructive Examination |
| 2.                                  | AWS D1.3/D1.3M-08 | Structural Welding Code - Sheet Steel                                    |
| D. International Code Council (ICC) |                   |  |
| 1.                                  | IBC               | 2015 International Building Code   |

### **1.03 SYSTEM DESCRIPTION**

- A. Type of Metal Framing:
1. Cold form metal framing for structural support of wall and roof panels, gypsum board.
  2. Non-structural framing for gypsum board.

### **1.04 DESIGN REQUIREMENTS**

- A. Design in accordance with AISI S100 and IBC.
- B. Provide cold-formed metal framing capable of withstanding structure dead loads and loads shown on drawings.
- C. Support collateral loads imposed by doors, ventilating equipment, and other equipment and accessories to be supported by structure.
- D. Provide rough framing for louvers, doors, and openings as shown on drawings.
- E. Deflection Limits:
1. Exterior Load Bearing Wall Framing: Horizontal deflection of 1/360 of wall height. Design wall framing to resist horizontal deflection without contribution from wall sheathing.
  2. Exterior Non-Load Bearing Wall Framing: Horizontal deflection of 1/360 of wall height. Design wall framing to resist horizontal deflection without contribution from wall sheathing.
  3. Interior Load Bearing Wall Framing: Horizontal deflection of 1/360 of wall height under horizontal load of 5-pounds per square foot (lb/ft<sup>2</sup>).
  4. Interior Non-Load Bearing Wall Framing: Horizontal deflection of 1/360 of wall height under horizontal load of 5-lb/ft<sup>2</sup>.
  5. Roof Trusses: Vertical deflection of 1/360 of span.
  6. Roof Rafter Framing: Vertical deflection of 1/360 of horizontally projected span.
- F. Design framing system to provide for movement of components without damage, overstress, buckling, connection failure, undue stress on fasteners and anchors, or other detrimental effects.

- G. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary structure.
- H. Bolting: In accordance with AISI S100.

### **1.05 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 - Submittals.
- B. RSN 05 40 00-1, Approval Drawings and Data:
  - 1. Shop drawings:
    - a. Show framing plans, elevations, sections, layout, sizes, and dimensions. Include type, grade, size, and thickness of materials, including fasteners.
    - b. Welding symbols: In accordance with AWS A2.4.
    - c. Project-specific drawings except as permitted for details. Manufacturer's standard or typical drawings may be included to show details. Mark standard or typical drawings to indicate details relevant to project.
    - d. Sign and seal by design engineer.
  - 2. Manufacturer's product data:
    - a. Include complete descriptions of and specifications for metal framing, fasteners, accessories, and materials.
- C. RSN 05 40 00-2, Certifications:
  - 1. Affidavit certifying that sheet steel complies with specified quality, grade, and zinc coating.
- D. RSN 05 40 00-3, Erection Plans and Manual:
  - 1. Fabricator's erection plans and manual for framing system.

### **1.06 QUALIFICATIONS**

- A. Designer: Professional engineer registered in State of New Mexico.

### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver metal framing to jobsite in manufacturer's unopened containers or bundles identified with brand, type, and gage.
- B. Protect metal framing from damage and corrosion during storage and handling at jobsite:
  - 1. Store metal framing with sufficient clearance around materials to permit access for inspection and handling.
  - 2. Store and handle metal framing in manner that will not cause distortion.
  - 3. Store off ground in dry ventilated space.

4. When materials are stored outdoors, store materials off ground, supported on level platform, and protected from weather as approved by COR.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Sheet Steel for Studs, Runners, and Trusses and Accessories:
  1. 16-gage and heavier: ASTM A653, structural steel, G60 zinc coating, with minimum yield strength of 50,000 pounds per square inch (lb/in<sup>2</sup>).
  2. 18-gage and lighter: ASTM A653, structural steel, G60 zinc coating, with minimum yield strength of 33,000 lb/in<sup>2</sup>.

### **2.02 METAL FRAMING**

- A. Provide metal framing systems complete with studs, top and bottom runners (tracks), bridging, strapping, and other accessories as recommended by manufacturer for type, size, and length.
- B. Conform to ASTM C955 for structural metal framing.
- C. Conform to ASTM C645 and ASTM C754 for non-structural metal framing for non-structural framing for gypsum board.
- D. Furnish members and accessories from single manufacturer.

### **2.03 ANCHORS, CLIPS, AND FASTENERS**

- A. Steel Shapes and Clips:
  1. ASTM A36.
  2. Zinc coated in accordance with ASTM A123.
- B. Anchor Bolts and Studs Embedded in Concrete:
  1. ASTM A307, Grade A.
  2. Zinc coated in accordance with ASTM A153.
- C. Mechanical Fasteners:
  1. Corrosion-resistant coated, self-drilling, self-threading steel drive screws.
  2. Low-profile head beneath sheathing. Manufacturer's standard screw head elsewhere.

### **2.04 WELDING MATERIALS**

- A. In accordance with AWS D1.3.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify foundation, floor slab, mechanical and electrical utilities, and abutting structural framing are in correct position. Correct unsatisfactory conditions before proceeding with framing installation.

### **3.02 INSTALLATION**

- A. Install framing in accordance with approved shop drawings and fabricator's erection plans and manual.
- B. Framing may be prefabricated into panels prior to erection. Fabricate panels plumb, square, true to line, and braced to prevent racking.
- C. Cut framing components squarely or as required for attachment:
  - 1. Cut framing members by sawing or shearing.
  - 2. Do not torch cut.
- D. Maintain members in correct position until fastened.
- E. Fasten framing members by welding or screw fastening as standard with fabricator:
  - 1. Perform welding and related work in accordance with AWS D1.3. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used to correct welding work.
  - 2. Locate mechanical fasteners and install according to cold-formed metal framing manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.
  - 3. Wire tying of framing is not permitted.
- F. Handle and lift prefabricated panels in manner to prevent damage and distortion of members.
- G. Securely anchor tracks to supports.
- H. At butt joints, securely anchor two pieces of track to same supporting member or butt weld joints or splice with stud inserts.
- I. Plumb, align, and securely attach studs to flanges or webs of both upper and lower tracks.
- J. Align axially loaded members vertically to allow for full transfer of loads to foundation.
- K. Install jack studs above and below openings as required to furnish support. Securely attach jack studs to supporting members.

- L. Install headers in openings that are larger than stud spacing of wall.
- M. Attach bridging for studs in manner that prevents stud rotation.
- N. Install studs in one piece for their entire length. Splices are not permitted.
- O. Provide a load distribution member at top of track where joist or truss is not located directly over bearing stud.
- P. Provide end blocking where joist ends are not restrained from rotation.
- Q. Provide temporary bracing and leave in place until framing is permanently stabilized.
- R. Fasten reinforcement plate over web penetrations that exceed size of manufacturer's standard punched openings.
- S. Fasten framing members together by using self-drilling or self-tapping screws.
- T. Provide accurately aligned runners at top and bottom of partitions.
- U. Provide at least two studs at jambs of doors and other openings which are 24-inches wide or wider.
- V. Provide triple studs at corners, positioned to receive interior and exterior finishes.
- W. Fasten studs to top and bottom runners by welding or screwing both flanges to runners.
- X. Repair:
  - 1. Touch-up repair damaged shop-applied protective coatings after installation in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

**SECTION 05 50 00**  
**METAL FABRICATIONS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Metal Fabrications:

1. Payment: Lump sum prices offered in the Price Schedules:
  - a. Includes:
    - 1) Pipe guard posts.
    - 2) Channel supports for chlorine control panel.
    - 3) Electrical Equipment supports.
    - 4) Channel bases for electrical power equipment.
    - 5) Fasteners for complete installation of metalwork.
    - 6) Pipe guardrails for baffled outlet structure.

B. Cost: Include in prices offered in the Price Schedules for:

1. Plant-Precast Concrete Structures:
  - a. Grating.
  - b. Manhole frames and covers.
  - c. Ladder safety posts.
  - d. Precast concrete structure batten system.
  - e. Fasteners for complete installation of metalwork.
2. Baffled Outlet Structure:
  - a. Pipe guardrails.

**1.02 REFERENCE STANDARDS**

A. Aluminum Association (AA)

1. AA ADM-105 Aluminum Design Manual - 2015

B. American Institute of Steel Construction (AISC)

1. AISC 325-11 Steel Construction Manual - 13th Edition

C. American National Standards Institute (ANSI)

1. ANSI A14.3-2008 Ladders – Fixed – Safety Requirements

## D. American Society of Mechanical Engineers (ASME)

1. ASME B1.1-2003(R2008) Unified Inch Screw Threads (UN and UNR Thread Form)
2. ASME B18.2.1-2012 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

## E. ASTM International (ASTM)

1. ASTM A36/A36M-14 Carbon Structural Steel
2. ASTM A48/A48M-03(2016) Gray Iron Castings
3. ASTM A53/A53M-12 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
4. ASTM A108-13 Steel Bar, Carbon and Alloy, Cold-Finished
5. ASTM A123/A123M-17 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
6. ASTM A153/A153M-16a Zinc Coating (Hot-Dip) on Iron and Steel Hardware
7. ASTM A193/A193M-17 Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications
8. ASTM A276/A276M-17 Stainless Steel Bars and Shapes
9. ASTM A307-14e1 Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
10. ASTM A385/A385M-17 Providing High-Quality Zinc Coatings (Hot-Dip)
11. ASTM A536-84(2014) Ductile Iron Castings
12. ASTM A563-15 Carbon and Alloy Steel Nuts
13. ASTM A615/A615M-16 Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
14. ASTM A666-15 Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar
15. ASTM B209-14 Aluminum and Aluminum-Alloy Sheet and Plate
16. ASTM B221-14 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
17. ASTM B632/B632M-15 Aluminum-Alloy Rolled Tread Plate
18. ASTM D792-13 Density and Specific Gravity (Relative Density) of Plastics by Displacement

- |     |                                      |   |
|-----|--------------------------------------|---|
| 19. | ASTM D1004-13                        | Tear Resistance (Graves Tear) of Plastic Film and Sheeting  |
| 20. | ASTM D1505-10                        | Density of Plastics by the Density-Gradient Technique   |
| 21. | ASTM D1603-14                        | Carbon Black in Olefin Plastics   |
| 22. | ASTM D3895-14                        | Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry                              |
| 23. | ASTM D4833-07 (2013)                 | Index Puncture Resistance of Geomembranes and Related Products  |
| 24. | ASTM D5397 (2012)                    | Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test |
| 25. | ASTM D5596-03 (2016)                 | Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics                      |
| 26. | ASTM D5721-08(2013)                  | Air-Oven Aging of Polyolefin Geomembranes   |
| 27. | ASTM D5885-15                        | Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry   |
| 28. | ASTM D5994-10 (2015)                 | Measuring Core Thickness of Textured Geomembrane  |
| 29. | ASTM D6693-04 (2015)                 | Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes    |
| 30. | ASTM D7238-06 (2012)                 | Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus     |
| 31. | ASTM D7466-10 (2015)                 | Asperity Height of Textured Geomembrane   |
| 32. | ASTM F467-13e2                       | Nonferrous Nuts for General Use   |
| 33. | ASTM F593-13a                        | Stainless Steel Bolts, Hex Cap Screws, and Studs  |
| 34. | ASTM F594-09(2015)                   | Stainless Steel Nuts  |
| 35. | ASTM F844-07a                        | Washers, Steel, Plain (Flat), Unhardened for General Use  |
| F.  | American Welding Society, Inc. (AWS) |   |
| 1.  | AWS D1.1/D1.1M-10                    | Structural Welding Code – Steel   |
| 2.  | AWS D1.2/D1.2M-10                    | Structural Welding Code – Aluminum  |

- G. Commercial Item Description (CID)
1. CID A-A-1923A Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
- H. Geosynthetics Research Institute Standards (GRI)
1. GRI GM 13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- I. International Code Council (ICC)
1. ICC ES AC 308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete, November 2009
  2. ICC IBC – 2015 International Building Code
- J. National Association of Architectural Metal Mfrs. (NAAMM)
1. NAAMM MBG 531-17 Metal Bar Grating Manual
- K. Society of Protective Coatings (SSPC)/NACE International (NACE)
1. SSPC-SP 6/NACE 3-2007 Joint Surface Preparation Standard - NACE No. 3/ SSPC-SP 6 – Commercial Blast Cleaning

### **1.03 DEFINITIONS**

- A. Miscellaneous metalwork: Where either shown on drawings or specified elsewhere in this section or these specifications means metal fabrications as used in this section.

### **1.04 QUALIFICATIONS**

- A. Qualify welders in accordance with AWS D1.1 and AWS D1.2 using procedures, materials, and equipment of the type required for the work.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Store items in an enclosed area free from contact with soil and weather.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Aluminum: ASTM B209, alloy 6061-T6 (plates) and ASTM B221, alloy 6061 (bars).
- B. Aluminum Floor Plate: ASTM B632, alloy 6061-T6.

- C. Arc-Welding Electrodes:
1. Use filler metal and shielding gases suitable for base materials, positions, and other conditions.
  2. Filler metal and required shielding gases or fluxes: AWS D1.1 and AWS D1.2.
  3. Use filler metal with a minimum tensile strength of 70,000 pounds per square inch (psi) for steel.
  4. Aluminum alloy filler metal: AWS classification 4043.
- D. Bolts, Threaded Rods, Nuts, And Washers:
1. Bolts:
    - a. ASTM A307.
    - b. Length of bolt threads: ASME B18.2.1.
    - c. Thread class: Two free-fit, American National coarse-thread series.
  2. Threaded Rod:
    - a. ASTM B221.
    - b. Thread class: Two free-fit, American National coarse-thread series.
  3. Nuts:
    - a. Steel: ASTM A563.
    - b. Aluminum: ASTM F467.
  4. Washers:
    - a. Steel: ASTM F844, unhardened for general use.
    - b. Aluminum: ASTM B209.
- E. Expanded Metal: ASTM B209.
- F. Grating: NAAMM MBG 531 galvanized steel:
1. Welded grating.
  2. Where safety grating is required, provide serrated-edge grating.
  3. Banding bar: Unless otherwise shown on drawings, provide same size as bearing bars, where required.
- G. Steel Pipe: ASTM A53, Type E or S, Grade B:
1. Unless otherwise shown on drawings, provide standard-weight, black, steel pipe.
  2. Government inspection at mill and hydrostatic tests will not be required.
- H. Structural Steel:
1. Shapes except wide flange sections: ASTM A36.
  2. Bars and Plates: ASTM A36.

## **2.02 STAINLESS-STEEL MATERIALS**

- A. Structural Shapes: ASTM A276, Type 316.
- B. Plates: ASTM A666, Type 316.
- C. Stainless Steel Fasteners:
  - 1. Bolts: ASTM F593, hexagonal head.
  - 2. Nuts: ASTM F594, hexagonal head.
  - 3. Washers: Type 316, standard flat.
  - 4. Fasteners for Guardrails and Ladders: Stainless steel Type 316 rivets, 18-8 metal.
  - 5. Mechanical grating clips: Stainless steel, Type 316.

## **2.03 LADDERS**

- A. Safety Posts:
  - 1. "Ladder-Up" ladder extensions as manufactured by The Bilco Company, P.O. Box 1203, New Haven, CT 06505, or equal, having the following essential characteristics:
    - a. High-strength galvanized steel.
    - b. Tubular section that provides upward and downward movement and locks automatically when fully extended in up position.
    - c. Upward and downward movement controlled by stainless steel springs.
    - d. Operates in corrosive environment.
  - 2. Attach securely to ladder rungs.
  - 3. Extend a minimum of 42-inches above walking surface.

## **2.04 MANHOLE FRAMES AND COVERS**

- A. Manhole Frames and Covers:
  - 1. ERGO XL Access Assembly as manufactured by EJ Group, Inc, 270 Redwing Rd, Admore Industrial Air Park, Admore, OK 73401, or equal, having the following essential characteristics:
    - a. Ductile iron cover: ASTM A536.
    - b. Gray iron frame: ASTM A48, Class 35.
    - c. Load Rating: HS 20-44.
    - d. Cam lock security.
    - e. Hinged manhole assembly with mechanical lift assist:
      - 1) Opens to 120 degrees.
      - 2) Removable lid.

- f. Water resistant:
- g. Size: As indicated on drawings.

## **2.05 CHANNEL SUPPORTS FOR CHLORINE CONTROL PANEL**

- A. Type P1000 channel as manufactured by Unistrut Corporation, 35660 Clinton Street, Wayne, MI 48184, or equal, having the following essential characteristics:
  - 1. Channel: 1 5/8-inch wide by 1 5/8-inch deep with 7/8-inch opening.
  - 2. Thickness, minimum: 12 gauge (0.105-inches).
  - 3. Hot-dipped galvanized.
  - 4. Bolts, nuts, and washers: Hot-dipped galvanized.

## **2.06 ELECTRICAL EQUIPMENT SUPPORTS**

- A. Metal Framing:
  - 1. Combination channels as manufactured by Unistrut Corporation, 35660 Clinton Street, Wayne, MI 48184; Cooper B-Line, 509 West Monroe Street, Highland, IL 62249; or equal, having the following essential characteristics and accessories:
    - a. Combination channels: Cooper B-Line B12A, Unistrut P5501; or equal, having the following essential characteristics:
      - 1) No. 12 gauge steel.
      - 2) Channel: 1 5/8-inch wide by 4 7/8-inch deep with 7/8-inch opening.
      - 3) Hot-dipped galvanized.
    - b. Connection plates: Cooper B-Line B532, Unistrut P1726; or equal, having the following essential characteristics:
      - 1) Thickness: 1/4-inch.
      - 2) Hole spacing (from end): 13/16-inch.
      - 3) Hole spacing (on center): 1 7/8-inch.
      - 4) Width: 1 5/8-inch.
      - 5) Hole diameter: 9/16-inch.
      - 6) Hot-dipped galvanized.
    - c. Bolts, nuts, and washers:
      - 1) Bolts: ASTM A307.
      - 2) Nuts: Spring nuts, suitable for channel strut attachments.
      - 3) Washers: ASTM F844.
      - 4) Hot-dipped galvanized.

- B. Fabricated Plates:
1. ASTM A36 steel, galvanized.

## 2.07 ANCHORS

- A. Adhesive Anchors: Drilled type, installed with a chemical adhesive system:
1. Seismic qualified per ICC IBC and ICC ES AC 308 for seismic design category A through F and cracked concrete conditions.
  2. Adhesive: HIT-RE 500-SD epoxy adhesive manufactured by HILTI, P.O. Box 21148, Tulsa, OK 74121; or equal, having the following essential characteristics:
    - a. Injectable 2-component epoxy adhesive.
    - b. Dual packaging system designed for automatic mixing during injection.
    - c. Weathering resistant.
    - d. Resistant against high temperatures.
    - e. Suitable for use in diamond cored or pneumatic drilled holes.
    - f. Extended temperature range from 41 degrees F to 120 degrees F.
  3. Threaded carbon steel anchor rod: HAS Super rod manufactured by HILTI, P.O. Box 21148, Tulsa, OK 74121; or equal, having the following essential characteristics:
    - a. Rod material: ASTM A193, Grade B7.
    - b. Thread: ASME B1.1, continuously threaded (all-thread).
    - c. Fabricate with 45-degree chisel point on one end to facilitate insertion into adhesive-filled hole.
    - d. Hot-dip galvanized.
  4. Nuts and washers: As recommended by anchor manufacturer.
  5. One capsule length minimum bolt length, unless indicated otherwise on drawings.
- B. Expansion Anchors: Kwik Bolt 3 torque controlled expansion anchor body, wedge, nut, and washer as manufactured by HILTI, P.O. Box 21148, Tulsa, OK 74121; or equal, having the following essential characteristics:
1. Meets the requirements of CID A-A-1923A, Type 4.
  2. Anchor body and wedge: Carbon steel.
  3. Nuts and washers: As recommended by anchor manufacturer.
  4. Bolt length: As shown on drawings. If not shown, provide bolt length with 3 1/2-inch minimum embedment.

- C. Headed Concrete Anchors (HCA): H4L headed concrete anchor as manufactured by Nelson Stud Welding, Incorporated, 9008 S. Thomas Avenue, Bridgeview, IL 60455; or equal, having the following essential characteristics:
1. ASTM A108.
  2. Flux-filled ends suitable for end welding to steel with automatically timed stud-welding equipment.

## **2.08 STAINLESS STEEL ANCHORS**

- A. Stainless Steel Expansion Anchors: Kwik Bolt 3 SS 316 torque controlled expansion anchor body, wedge, nut, and washer as manufactured by HILTI, P.O. Box 21148, Tulsa OK 74121; or equal, having the following essential characteristics:
1. Externally threaded wedge bolt anchor.
  2. Meets the requirements of a CID A-A-1923A, Type 4 anchor.
  3. Anchor Body and Wedge: Stainless steel, Type 316.
  4. Nuts and Washers: As recommended by anchor manufacturer.
  5. Bolt Length: As shown on drawings. If not shown, provide bolt length with 3 1/2-inch minimum embedment.

## **2.09 GUARD POSTS**

- A. Steel Pipe: ASTM A53, Type E or S, Grade B:
1. Unless otherwise shown on drawings, provide standard-weight, black, steel pipe.
  2. Government inspection at mill and hydrostatic tests will not be required.
- B. Concrete:
1. In accordance with the applicable requirements of Section 03 30 00 – Cast-In-Place Concrete.
  2. 3/4-inch maximum size aggregate.
  3. Minimum compressive strength of 4,500 pounds per square inch at 28-days.
- C. Reinforcing Bars:
1. ASTM A615, Grade 60.
  2. Deformed steel bar.
- D. Painting:
1. In accordance with Section 09 96 20 – Coatings.

## 2.10 CHANNEL BASES FOR ELECTRICAL POWER EQUIPMENT

- A. Structural Steel:
1. C Shape: ASTM A36.
  2. Size: As indicated on drawings.
- B. Expansion Anchors: As indicated on drawings.
- C. Grout:
1. In accordance with applicable requirements of Section 03 62 20 – Non-Shrink Grout for Equipment and Metalwork.

## 2.11 HDPE GEOMEMBRANE FOR PRECAST CONCRETE BATTEN SYSTEM

- A. HDPE Geomembrane:
1. 80-mil HDPE (High Density Polyethylene) Double Textured (textured on both sides) meeting requirements of GRI GM 13.
  2. Stabilizers and biocides: Impart durability.
  3. Pigment:
    - a. Carbon black to produce opaque film ranging from dark gray to black in color.
    - b. Disperse carbon black evenly to produce a uniform color.
  4. Finish: Textured on both sides.
  5. Roll edges: Smooth (non-textured) to facilitate seaming.
  6. Uniform throughout and free from dirt, oil, foreign matter, scratches, cracks, creases, bubbles, tears, holes, pinholes, or other defects which may affect its serviceability.
  7. Conform to requirements of Table 05 50 00A - HDPE-Geomembrane Physical Properties. Unless otherwise indicated, required values are minimum average values when tested in weaker principle direction. Test frequency in accordance with GRI GM 13.
  8. Seam Strengths: 4 of 5 specimens must meet specified values. Fifth specimen must demonstrate 80 percent of listed value. Seam failure modes shall be Film Tear Bond (FTB).

Table 05 50 00A – HDPE-Geomembrane Physical Properties

Property	Test Method	Requirement
Thickness, minimum average	ASTM D5994	76 mils
Lowest individual, 8 of 10 readings		72 mils
Lowest individual of 10 readings		68 mils

Table 05 50 00A – HDPE-Geomembrane Physical Properties

Property	Test Method	Requirement
Asperity Height <sup>1</sup>	ASTM D7466	10 mils
Sheet Density	ASTM D1505 ASTM D792	0.94 g/cc
Tensile properties <sup>2</sup> : Yield Strength Breaking Strength Yield Elongation Break Elongation	ASTM D6693	168 lbs/inch 120 lbs/inch 12 percent 100 percent
Tear Resistance	ASTM D1004	56 lbs
Puncture Resistance	ASTM D4833	120 lbs
Stress Crack Resistance <sup>3</sup>	ASTM D5397	300-hours
Carbon Black Content <sup>4</sup>	ASTM D1603	2.0 to 3.0 percent
Carbon Black Dispersion	ASTM D5596	Note 5
Oxidative Induction Time (OIT) – Standard OIT	ASTM D3895	100-minutes
Oven Aging at 85 degrees C High pressure OIT – Percent retained after 90-days	ASTM D5721 ASTM D5885	80 percent
UV Resistance <sup>6</sup> High Pressure OIT – (Percent retained after 1600-hours)	ASTM D7238 ASTM D5885	50 percent
Roll Dimensions Width Length Area Gross Weight		23-feet 375-feet 8,625 square feet 3,470 lbs (approx.)

Table 05 50 00A – HDPE-Geomembrane Physical Properties

Property	Test Method	Requirement
----------	-------------	-------------

## Notes:

1. Of 10 readings; 8 must be  $\geq 7$  mils and lowest individual reading must be  $\geq 5$  mils.
2. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3-inches. Break elongation is calculated using a gauge length of 2.0-inches.
3. The yield stress used to calculate applied load for the SP-NCTL test should be the mean value via MQC testing.
4. Other methods such as ASTM D4218 or microwave methods are acceptable if an appropriate correlation can be established.
5. Carbon black dispersion for 10 different views. Nine in Categories 1 and 2 with one allowed in Category 3.
6. The condition of the test should be 20-hours UV cycle at 75 degrees C followed by 4-hours condensation at 60 degrees C.
7. UV resistance is based on percent retained value regardless of the original HP-OIT value.

**2.12 FABRICATION**

- A. Fabricate metalwork in accordance with AISC 325, AA ADM-105, and these specifications:
  1. Perform welding and related work in accordance with AWS D1.1 and AWS D1.2.
  2. Grind welds on ladders smooth.
- B. If straightening is necessary, use methods that will not injure metal.
- C. After shop work completion and before galvanizing, clean material of foreign substances.
- D. Ladders:
  1. Fabricate from standard weight pipe with diameter shown on drawings, or round HSS of same outside diameter and minimum wall thickness of 0.132-inches. Meet requirements of ANSI A14.3.
- E. Galvanizing:
  1. Galvanize items of metalwork as specified or shown on drawings. Use hot-dip galvanizing in accordance with ASTM A123 and ASTM A385.
  2. Galvanize bolts, nuts, washers, and locknuts in accordance with ASTM A153. Remove excess spelter by centrifugal spinning.

3. Fabricator's Galvanizing Repair:
  - a. Re-dip material with damaged galvanizing unless damage is local and can be repaired by 2 component epoxy zinc primer.
  - b. If galvanized coating becomes damaged after being dipped twice, material will be rejected.
  - c. Where local repair is authorized:
    - 1) Repair damage to galvanizing in accordance with Section 09 96 20 – Coatings.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Where locations and dimensions of miscellaneous metalwork shown on drawings are dependent upon existing equipment and/or equipment furnished, confirm locations and dimensions prior to fabrication of miscellaneous metalwork.

### **3.02 INSTALLATION**

- A. Embedded Metalwork:
  1. Locate metalwork to be embedded in concrete. Hold metalwork in correct position and alignment and protect metalwork from damage and displacement during placing and setting of concrete.
  2. Unless otherwise specified, use only metal braces, supports, and other items to position and align embedded metalwork, which will be embedded in concrete. Do not use wooden braces, supports, or other items to position and align embedded metalwork if they will also be embedded in concrete.
  3. Clean surfaces of metalwork to be in contact with or embedded in concrete grouting mortar in accordance with SSPC-SP 6/NACE 3.
- B. Anchors:
  1. Drill holes for anchors straight and true and of diameter recommended by anchor manufacturer.
  2. Install anchors in accordance with manufacturer's recommendations.
  3. Follow manufacturer's recommendations when embedded steel or reinforcement is encountered during drilling for anchors.
  4. When drilling water is used, clean surfaces of concrete to remain exposed immediately to prevent discoloration.
  5. Following drilling, clean holes with water to remove cuttings, followed by air to ensure holes are dry.

C. Guard Posts:

1. Install posts plumb in concrete footings as shown on drawings.
2. Fill posts with concrete and trowel top of post round for water drainage. Posts may be capped in lieu of filling posts with concrete.

D. Installer's Galvanizing Repair:

1. Repair damage to galvanizing in accordance with Section 09 96 20 – Coatings.

E. Holes in Metalwork:

1. Drill, or drill and tap as required, holes in metalwork required for installation.

F. Painting:

1. Paint surfaces of miscellaneous metalwork exposed after installation; except galvanized steel, and cast iron; in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

**SECTION 05 51 30**  
**ALUMINUM WALL LADDER AND PLATFORM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI A14.3-2002 Fixed Ladders - Safety Requirements

B. Code of Federal Regulations (CFR)

1. 29 CFR 1910.23 Guarding Floor and Wall Openings and Holes
2. 29 CFR 1910.27 Fixed Ladders

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 05 51 30-1, Approval Drawings and Data:

1. Manufacturer's shop drawings and product data.
2. Show dimensions, roof and wall mounting attachments, materials, construction, and finish.
3. Manufacturer's certification that ladder meets ANSI A14.3 and 29 CFR 1910.27 for fixed wall ladders and that platform meets 29 CFR 1910.23.

C. RSN 05 51 30-2, Instructions:

1. Manufacturer's installation instructions.

**PART 2 PRODUCTS**

**2.01 DESIGN REQUIREMENTS**

- A. Attach to metal building at location indicated on drawings.

## 2.02 LADDER AND PLATFORM

- A. Model RL53 Fall Arrest Access Ladder with Lead on Handrails manufactured by FixFast USA, 6210 S. Indianapolis Road, Whitestown IN 46075; or equal, having following essential characteristics:
1. Conforms to ANSI A14.3 and 29 CFR 1910.27.
  2. Fixed wall ladder type with fall arrest system.
  3. Fabricated from aluminum alloy.
  4. Rungs:
    - a. Raised button, serrated-edge, or metal bonded encapsulated grit surface.
    - b. 1 1/4-inch diameter.
    - c. Concentrated design load at center of rung, minimum: 200-pounds.
    - d. Rung length: 18-inches minimum.
- B. Platform and Handrails:
1. Conforms to 29 CFR 1910.23.
  2. Length: 4-feet.
  3. Fabricated from aluminum alloy.
  4. Grip strut floor and toe boards.
  5. Railings: 1 1/2-inch diameter, tube with cast aluminum railing fittings.
  6. Furnish with toe guard.
  7. Design live load: 100 pounds per square foot.
  8. Suitable for roof attachment.
- C. Ladder Security Panel/Door:
1. Fabricate from aluminum alloy sheet, 0.063-inch thick, minimum.
  2. Hinged and fabricated with hasps for padlocking.
  3. Minimum length: 7-feet.
- D. Harness Systems:
1. Coordinate wall ladder and platform harness systems with harness systems required for fall protection rail system. See Section 05 52 20 – Fall Protection Rail System. Utilize one harness system for both applications if feasible.
  2. Full body harness.
  3. Universal fit.
  4. Vest style.
  5. Furnish 2 complete personnel safety harness system packages for each system.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Attach ladder and platform to metal building structural members designed to support imposed loads. See Section 13 34 21 – Metal Building System.

**END OF SECTION**

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**SECTION 05 52 20**  
**FALL PROTECTION RAIL SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. Code of Federal Regulations (CFR)

1. 29 CFR 1926.500, Subpart M          Fall Protection

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 05 52 20-1, Approval Drawings and Data:

1. Manufacturer's shop drawings and product data.
2. Show layout, details, and attachment of rail system to metal building.
3. Manufacturer's certification that rail system meets 29 CFR 1926.500.

C. RSN 05 52 20-2, Instructions:

1. Manufacturer's installation instructions.

D. RSN 05 52 20-3, Operation and Maintenance Manual:

1. Use and maintenance instructions.

**PART 2 PRODUCTS**

**2.01 DESIGN REQUIREMENTS**

A. Railing System:

1. Conform to 29 CFR 1926.500, subpart M.
2. Attach to metal building at location indicated on drawings.
3. Function as fall restraint and fall arrest system, allowing continuous hands-free roof access for personnel wearing body harness attached to traveling tether and rail.

## **2.02 FALL PROTECTION RAIL SYSTEM**

### **A. Fall Protection Rail System:**

1. Roofsafe Rail System fall protection rail system manufactured by 3M / DBI Sala (Capital Safety), 3833 Sala Way, Red Wing MN 55066; or equal, having following essential characteristics:
  - a. Rail, baseplate, spreader plates, end stop, and carriages: Fabricated from extruded aluminum alloy, anodized.
  - b. Capable of traversing corners and slope changes.
  - c. Capable of being locked at any location along rail for stationary anchor.
  - d. Manufacturer's standard roof attachment connections: Suitable for metal roof profile.
  - e. Rivets and seal: Self-healing rivet, bulb-type with seal.
  - f. Hands-free continuous movement along entire length of rail.
2. Rail Carriages:
  - a. Furnish 2 carriages per system.
  - b. Designed to allow free travel along entire length of rail.

### **B. Harness Systems:**

1. FS 5200 Series Matrix Full Body Harnesses manufactured by Hy-Safe Technology, 964 Commerce Drive, Union Grove WI 53182; or equal, having following essential characteristics:
  - a. Universal fit.
  - b. Vest style.
  - c. 5-point adjustable.
2. Coordinate fall protection rail system harness systems with harness systems required for aluminum wall ladder and platform. See Section 05 51 30 – Aluminum Wall Ladder and Platform. Utilize one harness system for both applications if feasible.
3. Furnish 2 complete personnel safety harness system packages for each system.
4. Lanyard:
  - a. Lanyard with internal shock.
  - b. Length: 6-foot.
  - c. Furnish 2 for each system.

## **2.03 STORAGE LOCKERS**

- A. To accommodate harness systems.
- B. See Section 10 51 00 – Lockers.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Attach rail system to metal building structural members or preinsulated metal roof panel standing seams designed to support imposed loads. See Section 13 34 21 – Metal Building System.

**3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. After installation, test and certify rail system:
  - 1. Testing and certification shall be performed under supervision of manufacturer's representative.

**3.03 TRAINING**

- A. Onsite training shall be presented by Manufacturer's Representative:
  - 1. Train operating personnel in use of safety harness and fall protection rail system.
  - 2. Make arrangements for training with COR.

**END OF SECTION**

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**SECTION 06 82 10**  
**FIBERGLASS REINFORCED PLASTIC (FRP) FABRICATIONS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Fiberglass Reinforced Plastic (FRP) Fabrications:

1. Payment: Lump sum prices offered in the Price Schedules:
  - a. Includes:
    - 1) Structural shapes for platforms and stairs.
    - 2) Embedded angles for trench grating support.
    - 3) Gratings and stair treads.
    - 4) Guardrails.
    - 5) Stainless steel shapes, plates, fasteners, and adhesive anchors for FRP installation.

**1.02 REFERENCES**

A. American Society of Mechanical Engineers (ASME)

1. ASME B1.1-2003(R2008) Unified Inch Screw Threads (UN and UNR Thread Form)
2. ASME B18.2.1-2012 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head and Lag Screws (Inch Series)

B. ASTM International (ASTM)

1. ASTM D495-14 High Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation
2. ASTM D732-17 Shear Strength of Plastics by Punch Tool
3. ASTM D635-14 Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
4. ASTM D638-14 Tensile Properties of Plastics
5. ASTM D695-15 Compressive Properties of Rigid Plastics
6. ASTM D696-16 Coefficient of Linear Thermal Expansion of Plastics Between -30° C and 30° C with a Vitreous Silica Dilatometer

- |      |  |   |
|------|--|---|
| 7.   | ASTM D790-17   | Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| 8.   | ASTM D2344/D2344M-16                                 | Short Beam Strength of Polymer Matrix Composite Materials and Their Laminates                   |
| 9.   | ASTM E84-17  | Surface Burning Characteristics of Building Materials   |
| 10.  | ASTM F436/F436M-16                                   | Hardened Steel Washers  |
| <br> |  |   |
| C.   | American Welding Society (AWS)                       |   |
| 1.   | AWS D1.6/D1.6M-2017                                  | Structural Welding Code – Stainless Steel   |
| <br> |  |   |
| D.   | Fiberglass Grating Manufacturers Council (FGMC)      |   |
| 1.   | American National Standard-2014                      | FRP Composites Grating Manual for Pultruded and Molded Grating and Stair Treads                 |
| <br> |  |   |
| E.   | International Code Council (ICC)                     |   |
| 1.   | ICC-ES AC 308  | Post-Installed Adhesive Anchors in Concrete Elements, May 2014                                  |
| 2.   | IBC - 2015   | International Building Code   |
| <br> |  |   |
| F.   | International Organization for Standardization (ISO) |   |
| 1.   | ISO 9001:2015  | Quality Management Systems-Requirements   |
| <br> |  |   |
| G.   | Occupational Safety and Health Administration (OSHA) |   |
| 1.   | 29 CFR Part 1910                                     | Occupational Safety and Health Standards  |

### **1.03 DEFINITIONS**

- A. Where shown on drawings or specified elsewhere in this section or these specifications, “FRP fabrications” mean Fiberglass Reinforced Plastic fabrications as used in this section.

### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals:
1. All data, calculations, and drawings submitted to be checked and stamped by a professional engineer registered in State of New Mexico.
- B. RSN 06 82 10-1, Commercial Product Data:
1. Manufacturer’s published literature, including structural design data, structural properties data, grating load/deflection tables, corrosion resistance tables,

certificates of compliance, test reports as applicable, concrete anchor systems and their allowable load tables, and design calculations for systems not sized or designed in contract drawings:

- a. Manufacturer shall provide certification of corrosion and test data, including ASTM E84 tests, on FRP products from an independent testing laboratory. Test data shall be from full scale testing of actual production FRP items in standard chemical environments, of same type and material supplied on project.
  - b. Test data performed only on base resin will not be acceptable.
2. Submitted product data shall be from a single FRP manufacturer.
- C. RSN 06 82 10-2, Approval Drawings:
1. Manufacturer's shop and installation drawings: Clearly showing material sizes, types, styles, part or catalog numbers, complete details for fabrication and erection of components including, but not limited to, location, length, span directions, type and sizes of fasteners, clip angles, member sizes, and connection details.
  2. Submitted approval drawings shall be from a single FRP manufacturer.

## **1.05 DELIVERY, STORAGE, AND PROTECTION**

- A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing label of manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- B. Storage of Products: Handle materials carefully to prevent abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees F (21 and 29 degrees C) until required.
- C. Remove and replace damaged items with new items.

## **1.06 QUALITY ASSURANCE**

1. Manufacturer: All FRP components shall be furnished by only one manufacturer having a minimum of 10-years' experience in design and manufacture of similar products and systems:
  - a. Manufacturer shall be certified to ISO 9001 standard.
2. Installer: FRP installer shall have at least 5-years' experience in installation of fiberglass reinforced plastics. Additionally, if requested, a record of at least 5 previous, separate, similar successful installations in the last 5-years shall be provided.

3. FRP components shall be as free as commercially possible from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits.
4. Manufacturer shall offer 3-year limited warranty on all FRP products against defects in materials and workmanship.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Fiberglass Reinforced Plastics (FRP): All furnished fiberglass systems and components shall be from a single FRP manufacturer:
  1. General Manufacture Requirements:
    - a. Pultruded fiberglass shapes and components with flame retardant polyester or vinyl ester resin and chemical resistance:
      - 1) With finished surfaces that are smooth, resin-rich, free of voids, and without dry spots, cracks, crazes, or unreinforced areas.
      - 2) With glass fibers that are well covered with resin to protect against their exposure due to wear or weathering.
    - b. Protected from UV attack with integral UV inhibitors in resin and synthetic surfacing veil to help produce resin-rich surface.
    - c. FRP composites of high strength and high stiffness pultruded elements with continuous fiberglass rovings and strand mat reinforcements.
  2. Fire Rating: Meets Class 1 flame spread rating of 25 or less, when tested in accordance with ASTM E84.
  3. Flammability: Meets self-extinguishing requirements of ASTM D635.

### **2.02 FRP STRUCTURAL SHAPES, PLATES AND BARS**

- A. Dynaform pultruded shapes and plates, as manufactured by Fibergrate Composite Structures Incorporated, 5151 Belt Line Road, Suite 1212, Dallas, TX 75254, [www.fibergrate.com](http://www.fibergrate.com); or equal, having the following essential characteristics:
  1. Pultruded fiberglass components of sizes and shapes shown on drawings.
  2. Minimum mechanical properties, when tested in accordance with ASTM D638 and ASTM D695:
    - a. Shapes:
      - 1) Tensile stress, lengthwise: 30,000 pounds per square inch (psi).
      - 2) Tensile stress, crosswise: 7,000 psi.
      - 3) Compressive stress, lengthwise: 30,000 psi.
      - 4) Compressive stress, crosswise: 15,000 psi.

- b. Plates and Bars:
  - 1) Tensile stress, lengthwise: 20,000 psi.
  - 2) Tensile stress, crosswise: 10,000 psi.
  - 3) Compressive stress, lengthwise: 24,000 psi.
  - 4) Compressive stress, crosswise: 17,500 psi.
- 3. Chemical Resistance:
  - a. Resin shall be capable of withstanding frequent exposure of grating to splashes and spills from liquid sodium hypochlorite solution at 10% concentration.

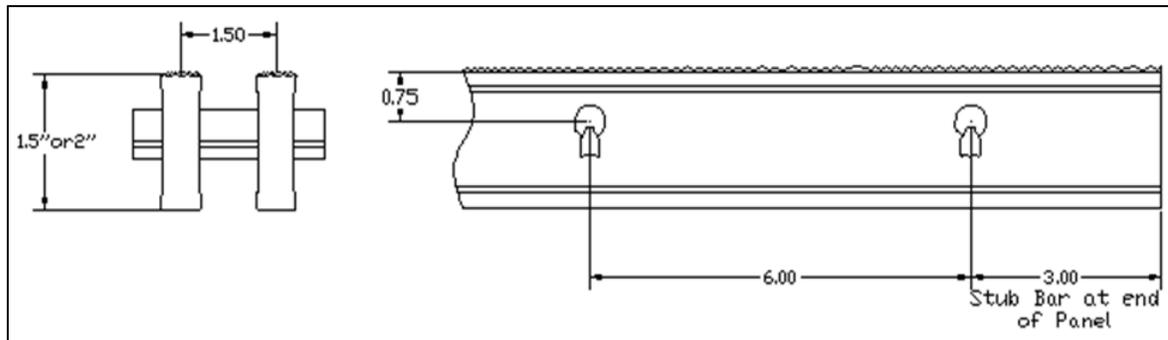
### **2.03 FRP CONCRETE CURB ANGLE**

- A. Pultruded FRP embedment curb angle, as manufactured by Grating Pacific Southwest, LLC, 8401 W. Sherman Street, Tolleson, AZ 85353, [www.gratingpacific.com](http://www.gratingpacific.com), or equal having the following essential characteristics:
  - 1. Dimensions: As indicated on drawings.
  - 2. Manufactured from corrosion resistant, gray vinyl ester, fire retardant resin.
  - 3. Manufactured with a built-in continuous anchor that securely locks the angle into the concrete placement.

### **2.04 FRP GRATING**

- A. Safe-T-Span Type I6015, as manufactured by Fibergrate Composite Structures Incorporated, 5151 Belt Line Road, Suite 1212, Dallas, TX 75254, [www.fibergrate.com](http://www.fibergrate.com); or equal, having the following essential characteristics:
  - 1. Design Requirements:
    - a. Depth: 1 1/2-inch deep bearing bars.
    - b. Loading:
      - 1) Pumping Plants: Uniform live load of 300 pounds-per-square foot (psf).
      - 2) Chemical Building: Uniform live load of 150 pounds-per-square foot (psf).
    - c. Maximum span: 42-inches.
    - d. Maximum deflection for above design live load: 1/4-inch.
  - 2. Physical Dimensions:
    - a. Bearing bars shall be interlocked and epoxied in place with two piece cross rod system to provide mechanical and chemical lock.
    - b. Cross bars or rods shall be below walking surface of grating.

- c. At ends of grating panels, provide flat banding bars same depth as bearing bars and epoxy ends of every bearing bar to banding bar, as recommended by manufacturer.
- d. Grating Configuration:
  - 1) Bearing bars spaced at 1 1/2-inches on centers, tie bar spaced at 6-inches on centers, placed 3/4-inch from top of bearing bar for 1 1/2-inch deep grating, as shown below:



\*\*All units are in inches

3. Non-slip surfacing: Grating shall be manufactured with an integrally applied grit to top surface of each bar providing maximum slip resistance.
4. Color: Safety yellow.
5. Mechanical grating clips: Provide Type 316 stainless steel clips as recommended by manufacturer.
6. Chemical Resistance:
  - a. Resin shall be capable of withstanding frequent exposure of grating to splashes and spills from liquid sodium hypochlorite solution at 10% concentration.

## 2.05 FRP STAIR SYSTEM

- A. FRP Stair System comprised of FRP Structural Shapes, Plates and Bars (see Article 2.02) and FRP Grating (see Article 2.04):
  1. Design Requirements:
    - a. Stair tread grating depth: See FRP Grating.
    - b. Stair tread loading: See FRP Grating and OSHA 1910.25(b)(6) – Stairways.
    - c. Stair tread maximum span: See FRP Grating.
    - d. Stair tread maximum deflection for above design live load: See FRP Grating.
  2. Physical Dimensions: See FRP Grating
  3. Non-slip surfacing: See FRP Grating.

4. Color: See FRP Grating.
5. Mechanical stair tread clips: Provide Type 316 stainless steel clips as recommended by manufacturer.

## **2.06 FRP GUARDRAILS**

- A. Dynarail fiberglass guardrail system, as manufactured by Fibergrate Composite Structures Incorporated, 5151 Belt Line Road, Suite 1212, Dallas, TX 75254, [www.fibergrate.com](http://www.fibergrate.com); or equal, having the following essential characteristics:
  1. Design load: Concentrated load of 200-pounds at any point on top rail, in accordance with OSHA 1910.23.
  2. Two-rail guardrail, with pultruded fiberglass square (or round) posts and rails and kickplates:
    - a. Minimum height: 42-inches.
    - b. Maximum spacing between posts: 5-feet 0-inches.
    - c. Maximum spacing between rails: 1-foot 9-inches.
  3. Component Minimum Dimensions:
    - a. Rails:
      - 1) Size: 1 3/4-inch square or 1.90-inch OD round.
      - 2) Thickness: 0.125-inch (square) or 0.195-inch (round).
    - b. Posts:
      - 1) Size: 2-inch square or 1.90-inch OD round.
      - 2) Thickness: 0.156-inch (square) or 0.195-inch (round).
    - c. Kickplate: 4-inch wide, minimum 1/4-inch thick.
  4. Color: Safety yellow.
  5. Chemical Resistance:
    - a. Resin shall be capable of withstanding frequent exposure of grating to splashes and spills from liquid sodium hypochlorite solution at 10% concentration.

## **2.07 STAINLESS STEEL FOR FRP INSTALLATION**

- A. Stainless Steel Shapes, Plates, Fasteners, and Adhesive Anchors: In accordance with Section 05 50 00 – Metal Fabrications.

## **2.08 FRP FABRICATION**

- A. Fabricate FRP components and accessories in accordance with manufacturer's recommendations and these specifications.

- B. Structural shapes supplied shall meet minimum dimensional requirements as shown on drawings or specified.
- C. Verify measurements in field for work fabricated to fit field conditions as required by FRP manufacturer to complete work.
- D. Determine correct size and locations of required holes or coping from field dimensions before fabricating FRP components.
- E. All shop fabricated cuts or drilling shall be coated with polyester or vinyl ester resin to provide maximum corrosion resistance:
  - 1. Coat field fabricated cuts or drilling in accordance with manufacturer's instructions.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Where locations and dimensions of FRP fabrications or cut outs shown on drawings are tentative or subject to change dependent upon equipment furnished, confirm locations and dimensions prior to FRP fabrication.

### **3.02 INSTALLATION**

- A. Use stainless steel fasteners and accessories to assemble and install FRP fabrications. Refer to Section 05 50 00 – Metal Fabrications.
- B. Use stainless steel adhesive anchors to attach FRP fabrications to existing concrete. Refer to Section 05 50 00 – Metal Fabrications.
- C. Hold down grating clips: Gratings must be mechanically fastened in place to prevent sliding and lifting. Fasten each grating panel to each support using a minimum of four hold down clips. Larger grating panels may require six to eight hold down clips.
- D. Additional support for grating: Provide additional support for openings or cutouts in pultruded grating. For cantilever conditions of molded or pultruded grating, provide additional hold down clips at a minimum of two supports to prevent overturning of grating panels. Cantilevered grating shall not exceed 12-inches beyond centerline of support.
- E. Grout:
  - 1. Where shown on drawings, fill spaces under plates or shapes completely with nonshrink grout as required or shown on drawings and in accordance with Section 03 63 20 – Epoxy Grout.
- F. Holes in FRP fabrications:

- G. Drill or drill and tap, as required, holes in FRP and stainless steel fabrications required for complete installation.

**END OF CONTENTS**

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**SECTION 07 19 20**  
**SILANE WATER REPELLENT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Silane Water Repellent:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARD**

A. ASTM International (ASTM)

1. ASTM D5095-91(2013) Determination of the Nonvolatile Content in Silanes, Siloxanes, Silane-Siloxane Blends Used in Masonry Water Repellent Treatments

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 07 19 20-1, Approval Data:

1. Manufacturer's product data.

C. RSN 07 19 20-2, Instructions:

1. Manufacturer's storage, surface preparation, and application instructions.

D. RSN 07 19 20-3, Documentation:

1. Evidence of applicator's qualifications.
2. Include signed statement from water repellent manufacturer attesting to manufacturer's approval of applicator.

**1.04 QUALIFICATIONS**

A. Applicator Qualifications: Experienced applicator approved by water repellent manufacturer.

**1.05 FIELD SAMPLE**

A. Field Sample: Apply water repellent to 2- by 2-foot area of building wall designated by COR.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to jobsite in manufacturer's original unopened packaging with labels and seals intact.
- B. Store materials in protected area in accordance with manufacturer's instructions.

**1.07 ENVIRONMENTAL REQUIREMENTS**

- A. Do not apply when air or substrate temperature is below 45 degrees F.
- B. Comply with manufacturer's environmental restrictions.

**PART 2 PRODUCTS****2.01 SILANE WATER REPELLENT**

- A. Clear water-based silane water repellent.
- B. Nonvolatile Content: 98.7 percent, minimum, when tested in accordance with ASTM D5095.
- C. Deep penetrating, non-film forming solution.
- D. Does not contain silicone or urethane.

**PART 3 EXECUTION****3.01 PREPARATION**

- A. Allow masonry to cure for 30-days after manufacturing, minimum, before application of water repellent.
- B. Silane water repellent shall be applied after the application and curing of joint sealants. Refer to Section 07 92 00 – Joint Sealants and Masonry Joints.
- C. Prepare clean, dry substrate surface in accordance with manufacturer's instructions. Remove dirt, efflorescence, and foreign materials.

**3.02 APPLICATION**

- A. Apply to exterior concrete masonry surfaces.
- B. Mix and apply in accordance with manufacturer's instructions.
- C. Apply at coverage rate recommended by manufacturer for new masonry.

**3.03 CONTRACTOR FIELD QUALITY TESTING**

- A. Arrange for manufacturer's representative to perform following field services at jobsite:
1. Verify proper equipment will be used in work before work begins.
  2. Verify proper surface preparation and application methods will be used in work before work begins.
  3. Supervise specified field sample preparation and application.
  4. Verify proper application on treated surfaces.

**3.04 CLEANING**

- A. Remove drips, runs, and overspray residue by methods recommended by manufacturer.

**END OF SECTION**

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**SECTION 07 21 13**  
**SOUND CONTROL BATT INSULATION**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

B. ASTM International (ASTM)

1. ASTM C665-12 Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
2. ASTM E90-09 Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
3. ASTM E413-10 Classification for Rating Sound Insulation

**1.02 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 07 21 13-1, Approval Data:

1. Manufacturer's product data for approval.

C. RSN 07 21 13-2, Instructions:

1. Manufacturer's storage and installation instructions.

**1.03 DELIVERY, STORAGE, AND HANDLING**

D. Package and mark materials in accordance with ASTM C665.

E. Deliver materials to jobsite in manufacturer's original unopened packaging with labels intact.

F. Store materials in protected area in accordance with manufacturer's recommendations.

**PART 2 PRODUCTS****1.04 SOUND CONTROL BATTS**

- A. ASTM C665, Type I, fiberglass batt.
- B. Formaldehyde free.
- C. Recovered Material Content: Minimum 20 percent glass.
- D. Thickness: 6-1/2-inches.
- E. Width: Match frame spacing.
- F. Sound Transmission Class: Minimum 50 in accordance with ASTM E90 and ASTM E413.

**PART 3 EXECUTION****1.05 INSTALLATION**

- A. Install at locations shown on the drawings.
- B. Place to completely fill space to be insulated.
- C. Butt insulation tightly together and to intersecting surfaces.
- D. Friction fit insulation between framing without edge or end gaps.

**END OF SECTION**

**SECTION 07 21 20**  
**EXTRUDED POLYSTYRENE FOAM INSULATION**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

- A. ASTM International (ASTM)
1. ASTM C578-19 Rigid, Cellular Polystyrene Thermal Insulation

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 07 21 20-1, Approval Data:
1. Manufacturer's product data that indicates materials meet specified requirements.

**1.04 DELIVERY STORAGE AND HANDLING**

- A. Deliver materials to the site in the manufacturer's original unopened packaging.
- B. Protect from weather and sunlight.

**PART 2 PRODUCTS**

**2.01 EXTRUDED POLYSTYRENE FOAM INSULATION**

- A. ASTM C578, Type X.
- B. Apply to achieve thermal resistance value of R-19 at building walls, R-30 at building roofs, and R-14.6 at Chemical Building foundation walls.

**2.02 FOUNDATION COATING CEMENT**

- A. Foundation Coating Cement manufactured by Akona Manufacturing, LLC, 2025 Centre Pointe Boulevard Suite 300, Mendota Heights MN 55120; or equal, having the following essential characteristics:
1. Portland-cement based.
  2. Color: Gray.

- B. Apply at Chemical Building foundation walls where insulation extends above grade. Provide complete cover of insulation above grade. Extend coating 6-inches below grade, minimum.

### **2.03 ADHESIVE**

- A. Recommended by insulation manufacturer.

## **PART 3 EXECUTION**

### **3.01 SURFACE PREPARATION**

- A. Prior to installing insulation, ensure that areas that will be in contact with insulation are flat, smooth, compact, and free of foreign material, snow, ice, and standing water.
- B. Remove projections or voids on contact surfaces which could compress, puncture, crack, or dent insulation.

### **3.02 INSTALLATION**

- A. Install at locations shown on drawings.
- B. Install insulation in panels as large as practical to minimize joints.
- C. Cut and fit insulation to produce clean, sharp edges and corners.
- D. Cut and fit insulation closely around penetrations. Apply manufacturer's recommended sealant to seal gaps.
- E. Install insulation sections flush without gaps or offsets.
- F. Vertical installation: Spot apply adhesive as recommended by insulation manufacturer.
- G. Install foundation coating cement to manufacturer's standards.

**END OF SECTION**

**SECTION 07 21 50**  
**SPRAY-APPLIED POLYURETHANE FOAM INSULATION**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in applicable prices offered in the Price Schedules for:
    - a. Metal Building System.
    - b. Plant-Precast Concrete Structures.

**1.02 REFERENCE STANDARDS**

- A. ASTM International (ASTM)
1. ASTM C1029-13 Spray-Applied Rigid Cellular Polyurethane  
Thermal Insulation

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 07 21 50-1, Approval Data:
1. Manufacturer's product data.
- C. RSN 07 21 50-2, Instructions:
1. Manufacturer's product storage, surface preparation, environmental, and application instructions.
    - a. Include manufacturer's recommendations for cleaning and preparing each substrate material to be covered by insulation.
- D. RSN 07 21 50-3, Documentation:
1. Written evidence that applicator is approved by insulation manufacturer to apply product.

**1.04 QUALIFICATIONS**

- A. Applicator Qualifications: Experienced applicator approved by insulation manufacturer to apply product.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to jobsite in manufacturer's original unopened packaging with labels and seals intact.
- B. Store materials in protected area in accordance with manufacturer's instructions.

**1.06 ENVIRONMENTAL REQUIREMENTS**

- A. Comply with manufacturer's environmental restrictions.

**PART 2 PRODUCTS****2.01 SPRAY-APPLIED POLYURETHANE FOAM INSULATION**

- A. ASTM C1029, Type II.
- B. Thickness: To achieve required thermal resistance values.

**PART 3 EXECUTION****3.01 PREPARATION**

- A. Prepare clean, dry substrate surfaces in accordance with manufacturer's instructions:
  - 1. Remove dirt, petroleum products, corrosion, loose materials, and other substances which could affect proper adhesion of insulation.
- B. Mask and protect adjacent surfaces and equipment not to receive insulation from overspray.
- C. Obtain approval of surface preparation, masking, and protection from COR before proceeding with application of insulation.

**3.02 APPLICATION**

- A. Spray apply insulation in accordance with manufacturer's instructions and as shown on drawings.
- B. Apply to uniform monolithic density without voids.
- C. Apply to achieve thermal resistance value of:
  - 1. R-19 at building walls
  - 2. R-30 at building roofs
  - 3.  $7.5 \leq R \leq 9$  at plant-precast concrete structures

**END OF SECTION**

**SECTION 07 21 60**  
**INSULATION JACKET**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for applicable air valves with and without manholes.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 07 21 60-1, Approval Data:
1. Manufacturer's product data.
- C. RSN 07 21 60-2, Instructions:
1. Manufacturer's product storage, surface preparation, environmental, and application instructions.
    - a. Include manufacturer's recommendations for cleaning and preparing each substrate material to be covered by insulation.

**1.03 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to jobsite in manufacturer's original unopened packaging with labels and seals intact.
- B. Store materials in protected area in accordance with manufacturer's instructions.

**PART 2 PRODUCTS**

**2.01 INSULATION JACKET**

- A. Removable Box Jacket, manufactured by ThermaXX Jackets, LLC, 16 Hamilton Street, West Haven, CT 06516, [www.thermaxxjackets.com](http://www.thermaxxjackets.com) or equal with the following essential characteristics:
1. Equivalent R value of 20.
  2. Accommodate operation of valve.
  3. Removable and replaceable.

**PART 3 EXECUTION****3.01 PREPARATION**

- A. Prepare clean, dry substrate surfaces in accordance with manufacturer's instructions.
  - 1. Remove dirt, petroleum products, corrosion, loose materials, and other substances which could affect proper adhesion of insulation.
- B. Obtain approval of surface preparation from COR before proceeding with application of insulation.

**3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.

**END OF SECTION**



9.	ASTM E1399	Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
10.	<u>ASTM E1646</u>	<u>Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference</u>
11.	<u>ASTM E1680</u>	<u>Rate of Air Leakage through Exterior Metal Roof Panel Systems</u>

### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 07 41 13-1, Sample and Color Sample Kit:
1. Complete set of manufacturer’s standard color samples, finish samples, and texture samples for selection of panel color, finish, and texture. Color copies of these items are not acceptable and will be returned not approved.
  2. Coordinate Pre-Insulated Metal Roof Panels color, finish, and texture selection with Sections 04 22 10 – Reinforced Concrete Unit Masonry Assemblies, 07 42 13 – Pre-Insulated Metal Wall Panels, 07 72 30 – Roof Hatches, and 08 33 20 – Roll-Up Doors.
  3. Provide 6-inch-long section of gutter/cornice.
- C. RSN 07 41 13-2, Qualifications.
- D. RSN 07 41 13-3, Product Data and Shop Drawings:
1. Product Data: Metal panels, edges, joints, profiles, corners, anchorages, attachments, trim, flashings, closures and accessories approval data:
    - a. Include complete descriptions of and specifications for roof panels and materials including material type, grade, metal thickness, and finish.
  2. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details including layout and installation details of roof and gutter de-icing system.
  3. Product test reports.
- E. RSN 07 41 13-4, Closeout Maintenance Data.

### 1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding effects of the following loads, based on testing according to ASTM E72:
1. Wind Loads: As shown on drawings.

2. Other Design Loads: As shown on drawings.

## 1.05 QUALIFICATIONS

- A. Installer Qualifications: Worked on 3 projects of similar scope.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Minimum R-value of 30 in accordance with ASTM C518.
- B. Water Penetration: No uncontrolled water penetration through the panel joints at a pressure differential of ~~20~~ 12 psf in accordance with ASTM ~~E1646~~ E331.
- C. Air Infiltration: Not to exceed ~~0.004~~ 0.01 cfm/sf at ~~20~~ 12 psf air pressure differential in accordance with ASTM ~~E1680~~ E283.
- ~~D. Sound Transmission Coefficient (STC): Minimum of 22 in accordance with ASTM E90 and ASTM E413.~~
- E. Insulating Core: Polyisocyanurate (ISO) core, ASTM C591 Type IV, CFC and HCFC free.
- F. Coatings: In accordance with manufacturer's recommendation and Section 09 96 20 – Coatings.

### 2.02 ROOF PANELS

- A. KingSeam, manufactured by Kingspan Insulated Panels, 2000 Morgan Road, Modesto CA 95358, or equal, with the following essential characteristics:
  1. Factory-formed standing seam insulated metal roof panels.
  2. Designed and manufactured to prevent through metal-to-metal contact between exterior and interior faces of installed system.
  3. Total Panel Thickness: 5-inches or as required to meet minimum R-value.
  4. Coatings:
    - a. Refer to Section 09 96 20 – Coatings.
    - b. In accordance with manufacturer's recommendations.
    - c. Factory applied.
  5. Exterior Face:
    - a. Material: AZ50/Galvalume/Zincalume, ASTM A792.
    - b. Texture: Non-directional stucco embossed.

- c. Finish: Manufacturer's standard.
  - d. Gauge: 24.
  - e. Overlapping rib 1 1/2-inch to 2-inch high at panel joint.
  - f. Color: To be determined by Government from manufacturer's standard color chart.
6. Interior Face:
- a. Material: AZ35/Galvalume/Zincalume, ASTM A792.
  - b. Texture: ~~Non-embossed~~ Non-directional stucco embossed.
  - c. Finish: Manufacturer's standard.
  - d. Gauge: 26.
  - e. Color: To be determined by Government from manufacturer's standard color chart.
- B. Fasteners:
- 1. Self-drilling fasteners shall be corrosion resistant plated steel, designed to resist maximum negative pulloff loads and hold face sheet mechanically to structural support.
  - 2. Panel attachment clip shall be fully concealed within panel side joint. Base clip shall be a minimum 14 gauge galvanized, and top clip shall be a minimum 20-gauge stainless steel with an integral thermal break.
  - 3. Vibration resistant type (anti-back out threads) fasteners. Self-drilling flathead screws with sealing washers and square drives, designed to resist back out by increasing thread friction as screw loosens.
  - 4. Size and Spacing: As recommended by manufacturer.
- C. Perimeter Trim and Penetration Treatments:
- 1. Fabricated perimeter trim, penetration treatments and fascia, and metal flashing: Same gauge, texture, material and coating color as exterior face of insulated metal roof panel.
- D. Sealants: Butyl, non-skinning/curing type as recommended by manufacturer.

### 2.03 ACCESSORIES

- A. Metal Roof Expansion Joint System: Model WJK manufactured by MM Systems Corp., 50 MM Way, Pendergrass GA 30567, or equal, having the following essential characteristics:
- 1. In accordance with ASTM E1399.
  - 2. Covers roof expansion joint openings while maintaining watertight integrity.

3. Cover plates to resist snow and wind loads.
  4. Color: Match pre-insulated metal roof panels.
- B. EPDM Flexible Boot Flashings: EPDM Flexible Flashing for Sloped Metal Roofs manufactured by Marco Industries, Tulsa OK 74145, or equal, having the following essential characteristics:
1. Flexible flashing consisting of EPDM upper flashing boot with triple pressure grommet seal, EPDM base seal, cast zinc hold-down ring, and silicone dipped aluminum lock rivets with synthetic rubber washer under rivet head.
  2. Fabricated for standing seam profile of metal roofing panels.
  3. Weep hole for first two fins of base seal on down slope side of seal.
  4. Size recommended by flashing manufacturer to match diameter of protruding pipe.
- C. Gutters and Downspouts:
1. As recommended by manufacturer.
  2. Gutter material, finish, and color: Pre-finished, to match building roof panels.
  3. Downspout material, finish, and color: Pre-finished, to match building wall panels.
- D. Roof and Gutter De-Icing System: IceStop System, control system, and accessories manufactured by Raychem and distributed by NVent, 7433 Harwin Drive, Houston TX 77036, or equal, having the following essential characteristics:
1. Design and install complete de-icing heat tracing system at roof eaves, gutters, and downspouts to prevent ice dams and clogging of gutters and downspouts by ice.
  2. System to consist of self-regulating heating cables, connection kits, and electronic controller.
  3. Self-regulating heating cables and connection kits:
    - a. UV resistant.
    - b. Components such that water ingress and corrosion are prevented.
  4. Electronic Controller.
  5. Accessories: Roof clips, hangars, and other items as required for a complete system.
- E. Ridge Cap and Insulation:
1. As recommended by the manufacturer.
  2. Material, finish, and color: Prefinished, to match that of pre-insulated metal roof panels.

- F. Splash Blocks:
  - 1. As shown on drawings.
  - 2. Precast concrete.
  - 3. 12-inches wide by 24-inches long by 3-inches high.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Provide field measurements to panel manufacturer.
- B. Supporting Steel: In accordance with Section 13 34 21 – Metal Building System:
  - 1. Verify that bearing support has been provided behind horizontal joints of vertical panel systems and behind vertical joints of horizontal panel systems.
  - 2. Width of support as recommended by manufacturer.
- C. Examine individual panels upon removing from bundle; notify manufacturer of panel defects.

### **3.02 INSTALLATION**

- A. Panel Installation:
  - 1. In accordance with manufacturer's installation guidelines and recommendations.
  - 2. Install panels plumb, level, and true-to-line to dimensions and layout indicated on shop drawings.
  - 3. Cut panels prior to installing, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blade per manufacturer's instructions.
  - 4. Butyl weather barrier sealant:
    - a. Apply non-skinning butyl sealant as shown on shop drawings and manufacturer's installation instructions as necessary to establish vapor barrier for panels.
    - b. Use non-skinning butyl tube sealant only for tight metal-to-metal contact.
    - c. Do not use non-skinning butyl tube sealant to bridge gaps.
  - 5. Place panel fasteners through pre-punched holes in attachment clips, concealed within joint of panel. Secure units to structural supports. Space clips as recommended by manufacturer or otherwise indicated on shop drawings.
- B. Trim Installation:
  - 1. Place fascia, trim and trim fasteners as indicated on shop drawings.

2. Field drill weep holes where appropriate in horizontal trim; minimum 1/4-inch diameter at 24-inches on center.
  3. Place continuous strip of butyl tube sealant between inside back face of closure trims and interior panel faces for proper weather seal.
- C. Metal Roof Expansion Joint System: Install per manufacturer's recommendations.
- D. EPDM Flexible Boot Flashings: Install per manufacturer's recommendations.
- E. Gutters and Downspouts: Install per manufacturer's recommendations.
- F. Roof and Gutter De-Icing System: Install per manufacturer's recommendations.
- G. Ridge Cap: Install per manufacturer's recommendations.
- H. Sealant Installation for Exposed Joints:
1. Clean and prime surfaces to receive exterior exposed sealants in accordance with sealant manufacturer's recommendations.
  2. Follow sealant manufacturer's recommendations for joint width-to-depth ratio, application temperature range, size and type of backer rod, and compatibility of materials for adhesion.
  3. Direct contact between butyl and silicone sealants shall not be permitted.

### **3.03 CONTRACTOR FIELD QUALITY**

- A. Field Water Test: After completing portion of metal roof panel assembly including accessories and trim, test a 2-bay area for each structure selected by COR for water penetration in accordance with AAMA 501.2.
- B. Cleaning and Protection:
1. Remove protective film immediately after installation.
  2. Touch-up, repair or replace metal panels and trim that have been damaged as approved by COR.
  3. After metal roof panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Roof and Gutter De-Icing System:
1. Start-up and testing of system shall be performed by manufacturer technician or representative.
  2. Field testing and inspections: Per manufacturer's recommendations.

**END OF SECTION**

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~~Doors under Specified Pressure Differences  
across the Specimen~~

8. ASTM E331 ~~*Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference*~~  
~~Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference~~
9. ~~ASTM E413-10~~ ————— ~~Classification for Rating Sound Insulation~~

### 1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E72:
1. Wind Loads: As shown on drawings.
  2. Other Design Loads: As shown on drawings.
  3. Deflection Limits: For wind loads, no greater than L/180 of the span.

### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 07 42 13-1, Sample and Color Sample Kit:
1. Complete set of manufacturer's standard color samples, finish samples, and texture samples for selection of panel color, finish, and texture. Color copies of these items are not acceptable and will be returned not approved.
  2. Coordinate Pre-Insulated Metal Wall Panels color, finish, and texture selection with Sections 04 22 10 – Reinforced Concrete Unit Masonry Assemblies, 07 41 13 – Pre-Insulated Metal Roof Panels, 07 72 30 – Roof Hatches, and 08 33 20 – Roll-Up Doors.
- C. RSN 07 42 13-2, Qualifications:
1. Installer qualifications.
- D. RSN 07 42 13-3, Product Data and Shop Drawings:
1. Product Data: Metal panels, edges, joints, profiles, corners, anchorages, attachments, trim, flashings, closures and accessories approval data:
    - a. Include complete descriptions of and specifications for wall panels and materials including material type, grade, metal thickness, and finish.
  2. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
  3. Product test reports.

- E. RSN 07 42 13-4, Closeout Maintenance Data.

## 1.05 QUALIFICATIONS

- A. Installer Qualifications: Worked on 3 projects of similar scope.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Water Penetration: No uncontrolled water penetration through panel joints at pressure differential of 20 psf in accordance with ASTM E331.
- B. Air Infiltration: Not to exceed ~~0.001~~0.01 cfm/sf at 20 psf air pressure differential in accordance with ASTM E283.
- C. ~~Sound Transmission Coefficient (STC): Minimum of 22 in accordance with ASTM E90 and ASTM E413.~~
- D. Insulating Core: Polyisocyanurate (ISO) core, ASTM C591 Type IV, CFC and HCFC free.
- E. Coatings: In accordance with manufacturer's recommendation and Section 09 96 20 – Coatings.

### 2.02 EXTERIOR METAL WALL PANELS

- A. KS Azteco ~~Embossed~~ Panels, manufactured by Kingspan Insulated Panels, 2000 Morgan Road, Modesto CA 95358, or equal, with the following essential characteristics:
1. Factory-formed insulated metal wall panels.
  2. Designed and manufactured to prevent through metal-to-metal contact between exterior and interior faces of installed system.
  3. Minimum R-value of 19 in accordance with ASTM C518.
  4. Total Panel Thickness: 3-inches or as required to meet minimum R-value.
  5. Coatings:
    - a. Refer to 09 96 20 – Coatings.
    - b. In accordance with the manufacturer's recommendations.
    - c. Factory applied.
  6. Exterior Face:
    - a. Material: ASTM A755. AZ50/Galvalume/Zincalume, ASTM A792.
    - b. Texture: Non-directional stucco embossed.

- c. Profile: Flat.
  - d. Finish: Manufacturer's standard.
  - e. Gauge: 24.
  - f. Color: To be determined by Government from manufacturer's standard color chart.
7. Interior Face:
- a. Material: ASTM A755. AZ50/Galvalume/Zincalume, ASTM A792.
  - b. Texture: Non-directional stucco embossed. ~~Non-embossed.~~
  - c. Profile: Shadowline.
  - d. Finish: Manufacturer's standard.
  - e. Gauge: 24.
  - f. Color: To be determined by Government from manufacturer's standard color chart.

### **2.03 INTERIOR METAL WALL PANELS**

- A. KS Shadowline Panels, manufactured by Kingspan Insulated Panels, 2000 Morgan Road, Modesto CA 95358, or equal, with the following essential characteristics:
- 1. Factory-formed insulated metal wall panels.
  - 2. Designed and manufactured to prevent through metal-to-metal contact between exterior and interior faces of installed system.
  - 3. Minimum R-value of 11.4 in accordance with ASTM C518.
  - 4. Total Panel Thickness: 2-inches or as required to meet minimum R-value.
  - 5. Coatings:
    - a. Refer to 09 96 20 – Coatings.
    - b. In accordance with the manufacturer's recommendations.
    - c. Factory applied.
  - 6. Exterior and Interior Faces:
    - a. Material: ASTM A755. AZ50/Galvalume/Zincalume, ASTM A792.
    - b. Texture: Non-directional stucco embossed.
    - c. Profile: Shadowline.
    - d. Finish: Manufacturer's standard.
    - e. Gauge: 24.
    - f. Color: To be determined by Government from manufacturer's standard color chart.

## **2.04 ACCESSORIES**

- A. Metal Wall Expansion Joint System: Expand-O-Flash Expansion Joint Cover manufactured by Johns Manville, Denver CO 80217, or equal, having the following essential characteristics:
  - 1. Covers wall expansion joint openings while maintaining watertight integrity.
  - 2. Accommodates multidirectional movement.
  - 3. Color: Match pre-insulated metal wall panels.
- B. Fasteners:
  - 1. Self-drilling fasteners shall be cadmium plated steel with neoprene washer, as recommended by manufacturer.
  - 2. Material: Hex-head type with steel and neoprene washer and 12-gauge stainless steel clip supplied by manufacturer.
  - 3. Size: As recommended by manufacturer.
- C. Perimeter Trim:
  - 1. Required trim and metal flashing shall be steel with same coating, color, and gauge as exterior face of pre-insulated metal wall panel.
- D. Sealants: Butyl, non-skinning/curing type as recommended by manufacturer.
- E. Butyl Tape: As recommended by manufacturer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Provide field measurements to panel manufacturer.
- B. Supporting Steel: In accordance to Section 13 34 21 – Metal Building System:
  - 1. Verify that bearing support has been provided behind horizontal joints of vertical panel systems and behind vertical joints of horizontal panel systems.
  - 2. Width of support as recommended by manufacturer.
- C. Examine individual panels upon removing from bundle; notify manufacturer of panel defects.

### **3.02 INSTALLATION**

- A. Panel Installation:
  - 1. In accordance with manufacturer's installation guidelines and recommendations.

2. Install panels plumb, level, and true-to-line to dimensions and layout indicated on shop drawings.
  3. Cut panels prior to installing, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blade per manufacturer's instructions.
  4. Butyl or Silicon Weather Barrier Sealant:
    - a. Apply non-skinning butyl sealant or silicon as shown on shop drawings and manufacturer's installation instructions as necessary to establish vapor barrier for panels.
    - b. Use non-skinning butyl tube sealant or silicon only for tight metal-to-metal contact.
    - c. Do not use non-skinning butyl tube sealant or silicon to bridge gaps.
  5. Place panel fasteners through pre-punched holes in attachment clips, concealed within joint of panel. Secure units to structural supports. Space clips as recommended by manufacturer or otherwise indicated on shop drawings:
    - a. Secure units to steel supports with manufacturer's recommended fastener. Adjacent panels shall be mechanically interlocked at their longitudinal edges with roll-formed tongue and groove profile.
    - b. Install horizontal panels from bottom to top. Place female side of bottom panel in base channel, clip and fasten to structural supports.
    - c. Install vertical panels from one end of wall to other end. Place female panel end in base, fasten to structural supports.
- B. Metal Wall Expansion Joint System: Install per manufacturer's recommendations.
- C. Trim Installation:
1. Place trim and trim fasteners as indicated on shop drawings.
  2. Field drill weep holes where appropriate in horizontal trim where indicated on shop drawings.
  3. Place continuous strip of butyl tape or tube sealant on closure trims for length of panel to be covered as indicated on shop drawings.
- D. Sealant Installation for Exposed Joints:
1. Clean and prime surfaces to receive exterior exposed sealants in accordance with sealant manufacturer's recommendations.
  2. Follow sealant manufacturer's recommendations for joint width-to-depth ratio, application temperature range, size and type of backer rod, and compatibility of materials for adhesion.
  3. Direct contact between butyl and silicone sealants shall not be permitted.

### **3.03 CONTRACTOR FIELD QUALITY**

- A. Field Water Test: After completing portion of metal wall panel assembly including accessories and trim, test 2-bay area selected by COR for each structure for water penetration in accordance with AAMA 501.2.
- B. Cleaning and Protection:
  - 1. Remove protective film immediately after installation.
  - 2. Touch-up, repair or replace metal panels and trim that have been damaged as approved by COR.
  - 3. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

**END OF SECTION**

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**SECTION 07 72 30**  
**ROOF HATCHES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost: Include in prices offered in the Price Schedules for:
1. Metal Building System:
    - a. Price Schedule 1 (Pumping Plant No. 4):
      - 1) Pumping Plant Roof:
        - a) (4) Double leaf roof hatches with 2-inch curb and cover insulation.
    - b. Price Schedule 2 (Pumping Plant No. 7):
      - 1) Pumping Plant Roof:
        - a) (4) Double leaf roof hatches with 2-inch curb and cover insulation.
  2. Plant-Precast Concrete Structures:
    - a. Price Schedule 1 (Pumping Plant No. 4):
      - 1) Flowmeter Vault Type I:
        - a) (1) Single leaf roof hatch.
      - 2) Flowmeter Vault Type II:
        - a) (1) Single leaf roof hatch.
        - b) (1) Double leaf roof hatch.
    - b. Price Schedule 2 (Pumping Plant No. 7):
      - 1) Flowmeter Vault Type III:
        - a) (2) Single leaf roof hatches.
        - b) (1) Double leaf roof hatch.

**1.02 REFERENCE STANDARDS**

- A. Aluminum Association (AA)
1. AA ADM-2010 Aluminum Design Manual
- B. ASTM International (ASTM)
1. ASTM D1056-07 Flexible Cellular Materials - Sponge or Expanded Rubber

- C. American Welding Society, Inc. (AWS)
  - 1. AWS D1.2/D1.2M-08                      Structural Welding Code - Aluminum

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 07 72 30-1, Sample and Color Sample Kit:
  - 1. Complete set of manufacturer's color samples. Color copies of these items are not acceptable and will be returned not approved.
  - 2. Coordinate Pumping Plant roof hatch color selection with Sections 04 22 10 – Reinforced Concrete Unit Masonry Assemblies, 07 41 13 – Preinsulated Metal Roof Panels, 07 42 13 – Preinsulated Metal Wall Panels, and 08 33 20 – Roll-Up Doors.
- C. RSN 07 72 30-2, Product Data and Shop Drawings:
  - 1. Product Data: Submit manufacturer's product data.
  - 2. Shop Drawings: Submit shop drawings including profiles, accessories, location, adjacent construction interface, and dimensions.

### **1.04 DELIVERY, STORAGE, AND PROTECTION**

- A. Protect from corrosion, deformation, and other types of damage.
- B. Store items in an enclosed area free from contact with soil and weather.
- C. Remove and replace damaged items with new items.

## **PART 2 PRODUCTS**

### **2.01 SINGLE LEAF ROOF HATCHES**

- A. Roof Hatches:
  - 1. Aluminum access hatches of sizes shown on drawings.
  - 2. Roof hatches: Type "S" as manufactured by the Bilco Company, P.O. Box 1203, New Haven, CT 06505; B-RH Series as manufactured by Babcock-Davis Hatchways, Incorporated, 50 Lowell Street, Arlington, MA 02174; or equal, having the following essential characteristics:
    - a. Single leaf.
    - b. Mill finish.
    - c. Twelve-inch high curb with 3 1/2-inch wide flange with holes for securing to the roof (hatch), 11 gauge aluminum with welded watertight corners.

- d. Curb insulation: 1-inch rigid fiberboard. Enclose curb insulation with metal of same material and gauge as curb.
- e. Covers: 11 gauge aluminum.
- f. Cover insulation: 1-inch thick glass fiber. Fully enclose with metal cover of 18-gauge aluminum.
- g. Heavy duty hinges.
- h. Spring operators to ease operation when opening hatch.
- i. Automatic hold-open device.
- j. Turn handles and padlock hasps on inside and outside.
- k. Weathertight and watertight.

## **2.02 DOUBLE LEAF ROOF HATCHES**

### **A. Roof Hatches:**

- 1. Aluminum access hatches of sizes shown on drawings.
- 2. Roof hatches: Type "D" as manufactured by the Bilco Company, P.O. Box 1203, New Haven, CT 06505; B-RH Series as manufactured by Babcock-Davis Hatchways, Incorporated, 50 Lowell Street, Arlington MA 02174; or equal, having the following essential characteristics:
  - a. Double leaf.
  - b. Finish:
    - 1) Kynar finish at Pumping Plant roof hatches. In accordance with Section 09 96 20 – Coatings.
    - 2) Mill finish at flowmeter vault hatches.
  - c. Twelve-inch high curb with 3 1/2-inch wide flange with holes for securing to the roof (hatch), 3/16-inch aluminum with welded watertight corners.
  - d. Curb insulation:
    - 1) 2-inch rigid at Pumping Plant roof hatches. Enclose curb insulation with metal of same material and gauge as curb.
    - 2) 1-inch rigid fiberboard at flowmeter vault hatches. Enclose curb insulation with metal of same material and gauge as curb.
  - e. Covers: 3/16-inch aluminum.
  - f. Cover insulation:
    - 1) 2-inch rigid at Pumping Plant roof hatches. Fully enclose with metal cover of 11 gauge aluminum.
    - 2) 1-inch rigid fiberboard at flowmeter vault hatches. Fully enclose with metal cover of 11 gauge aluminum.

- g. Heavy duty hinges.
- h. Spring operators to ease operation when opening hatch.
- i. Automatic hold-open device.
- j. Turn handles and padlock hasps on inside and outside.
- k. Weathertight and watertight.

### **2.03 MATERIALS**

- A. Gaskets:
  - 1. Dense sheet neoprene gaskets: ASTM D1056, Grade 2A1.
  - 2. Bond gasket to metal with manufacturer's standard adhesive.
- B. Expansion Anchors: In accordance with Section 05 50 00 – Metal Fabrications.

### **2.04 FABRICATION**

- A. Fabricate metalwork in accordance with AA ADM, and these specifications:
  - 1. Perform welding and related work in accordance with AWS D1.2.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install roof hatches as shown on drawings.
- B. Install roof hatches in accordance with manufacturer's instruction to be weathertight and watertight.
- C. Expansion Anchors: Install in accordance with Section 05 50 00 – Metal Fabrications.
- D. Painting:
  - 1. Paint surfaces of hatches exposed after installation, except aluminum and galvanized steel, in accordance with Section 09 96 20 – Coatings.
  - 2. Paint aluminum in contact with steel or concrete with one coat of industrial bituminous paint.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Spray hatches with water. Repair leakage as approved by COR.
- B. Inspect hatches for light infiltration. Repair as approved by COR.

**END OF SECTION**

**SECTION 07 92 00**  
**JOINT SEALANTS AND MASONRY JOINTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for applicable items of work.

**1.02 REFERENCES**

- A. ASTM International (ASTM)
1. ASTM C920-14 Elastomeric Joint Sealants

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 07 92 00-1, Approval Data and Color Samples:
1. Manufacturer's product data for each sealant and backing material.
  2. Manufacturer's color sample kit of cured sealant samples for color selection.
- C. RSN 07 92 00-2, Instructions:
1. Manufacturer's environmental, storage, surface preparation, installation, and cleanup instructions for each sealant and primer material.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to jobsite in manufacturer's original unopened packaging with labels and seals intact.
- B. Store materials in accordance with manufacturer's instructions.

**1.05 ENVIRONMENTAL REQUIREMENTS**

- A. Do not install sealant when ambient air temperature is below 40 degrees F or above 90 degrees F.
- B. Comply with sealant manufacturer's environmental restrictions.

## **PART 2 PRODUCTS**

### **2.01 MASONRY EXPANSION JOINTS**

#### **A. Backerseal:**

1. Backerseal (Greyflex), as manufactured by Emseal Joint Systems, LTD, [www.emseal.com](http://www.emseal.com), or equal, with the following essential characteristics:
  - a. Preformed foam sealant for use behind backer-rod and sealant.

#### **B. Backer Rod:**

1. Compatible with Sealant and Backerseal.

#### **C. Sealant:**

1. Non-sag Polyurethane Sealant:
  - a. ASTM C920, Type S, Grade NS, Class 25, Use M.
  - b. Single-component, non-sag polyurethane sealant.
  - c. Color: Match adjacent materials as close as possible. Color to be approved by COR prior to installation.

### **2.02 MASONRY CONTROL JOINTS**

#### **A. Backerseal:**

1. Backerseal (Greyflex), as manufactured by Emseal Joint Systems, LTD, [www.emseal.com](http://www.emseal.com), or equal, with the following essential characteristics:
  - a. Preformed foam sealant for use behind backer-rod and sealant.

#### **B. Backer Rod:**

1. Compatible with Sealant and Backerseal.

#### **C. Sealant:**

1. Non-Sag Polyurethane Sealant:
  - a. ASTM C920, Type S, Grade NS, Class 25, Use M.
  - b. Single-component, non-sag polyurethane sealant.
  - c. Color: Match adjacent materials as close as possible. Color to be approved by COR prior to installation.

### **2.03 SEALANTS**

- A. Provide sealant products that have been tested, found suitable, and documented as such by the manufacturer for the particular substrates to which they will be applied.

- B. Interior Sealants:
  - 1. ASTM C920, Type S, Grade NS, Class 25, Use NT.
  - 2. Color: Match adjacent materials as close as possible. Color to be approved by COR prior to installation.
- C. Exterior Sealants:
  - 1. For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT.
  - 2. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T.
  - 3. Color: Match adjacent materials as close as possible. Color to be approved by COR prior to installation.
- D. Floor Joint Sealants:
  - 1. ASTM C920, Type S or M, Grade P, Class 25, Use T.
  - 2. Color: Match adjacent materials as close as possible. Color to be approved by COR prior to installation.

## **2.04 ACCESSORIES**

- A. Primers: As recommended by sealant manufacturer for joint surface materials.
- B. Joint Cleaners: Noncorrosive and non-staining products recommended by sealant manufacturer for application.
- C. Joint Backing:
  - 1. Closed-cell round polyethylene foam rod compatible with sealant.
  - 2. Recommended by sealant manufacturer for application.
- D. Bond Breaker: Self-adhesive, pressure-sensitive polyethylene tape recommended by sealant manufacturer for application.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Preparation of Joint Surfaces:
  - 1. Clean and prepare joint in accordance with sealant manufacturer's instructions.
  - 2. Remove mortar, laitance, dust, coatings, curing compounds, petroleum products, corrosion, and other foreign material.
  - 3. Allow joint to dry.

4. Prime joint surfaces as recommended by manufacturer of joint materials.
- B. Backing Installation:
1. Install backing materials in accordance with sealant manufacturer's instructions.
  2. Use backing material to achieve required sealant depth.
  3. Use backing rod with diameter 25 percent greater than joint width.
  4. Use bond breaker in joints too shallow for backing rod.
- C. Obtain approval of joint preparation from COR before installation of sealant in joint.

### 3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Place sealant to depth specified in Table 07 92 00A - Depth of Sealant in Joints, or to depth specified by manufacturer's instructions, whichever is greater.

Table 07 92 00A - Depth of Sealant in Joints

Type of Joint	Joint Width	Sealant Depth
Joints in porous materials (concrete masonry, stone, etc.) and between porous materials and nonporous materials	1/4- to 3/8-inch	Equal to joint width
	3/8- to 3/4-inch	3/8-inch
	3/4-inch or greater	1/2-inch
Other joints	All widths	50 percent of joint width or 1/4-inch, whichever is greater

- C. Place and tool to smooth joints free of air pockets, embedded foreign material, ridges, and sags.

### 3.03 REPAIR

- A. Remove defective or contaminated sealant. Re-clean joint and replace sealant.

### 3.04 CLEANING

- A. Remove excess sealant and soiling from adjacent surfaces.

**END OF SECTION**

**SECTION 08 11 10**  
**STEEL DOORS AND FRAMES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. Commercial Item Description (CID)

1. CID A-A-1923A Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors), 21 August 2001

B. Steel Door Institute (SDI)

1. ANSI/SDI A250.8-14 Standard Steel Doors and Frames

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 08 11 10-1, Approval Drawings and Data:

1. Manufacturer's shop drawings:
  - a. Show dimensions, material gauges, framing members, reinforcements, hardware preparation and locations, anchorage details, and other fabrication and installation details.
  - b. Identify doors and frames by Government designations on drawings.
2. Manufacturer's product data for doors, frames, and accessory materials:
  - a. Include complete descriptions and specifications for materials, construction, and finish.
  - b. Identify doors and frames by Government designations on drawings.
3. Manufacturer's product data for grout to be used to fill frames.

C. RSN 08 11 10-2, Instructions:

1. Manufacturer's storage, handling, and installation instructions.

## **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Store and handle materials at jobsite in accordance with manufacturer's instructions and ANSI A250.8.

## **PART 2 PRODUCTS**

### **2.01 HOLLOW STEEL DOORS**

- A. Exterior Doors:
  - 1. ANSI A250.8, Level 3 and Physical Performance Level A, Model 2, hot-dipped zinc coated steel, 16 gauge.
  - 2. Core construction: Polyurethane or polystyrene.
  - 3. End closure: Flush end closure at top.
- B. Interior Doors: ANSI A250.8, Level 2 and Physical Performance Level B, Model 2, 18 gauge.

### **2.02 HOLLOW STEEL FRAMES**

- A. Exterior Door Frames: ANSI A250.8, hot-dipped zinc coated steel, face welded type.
- B. Interior Door Frames:
  - 1. Frames installed in masonry walls: ANSI A250.8, face welded type.
  - 2. Frames installed in gypsum board walls: ANSI A250.8, drywall slip-on type.
- C. Coordinate with Steel Window Frame at Control Room door location. See Specifications Section 08 51 20 – Steel Windows.

### **2.03 DOOR ACCESSORIES**

- A. Steel Astragals:
  - 1. Continuous steel astragal.
  - 2. Thickness: 1/8-inch.
  - 3. Width: 1 1/2-inches.

### **2.04 FRAME ACCESSORIES**

- A. Frame Anchors - Masonry Openings: Expansion anchor, spacer, and flush-mounted capscrew system with zinc-coated finish.
- B. Frame Anchors - Other Openings: ANSI A250.8.
- C. Mortar Guard Boxes: 22 gauge, minimum, sheet steel.

- D. Floor Anchors: ANSI A250.8.
- E. Expansion Anchors for Floor Anchors: CID A-A-1923A, Type 4.

## **2.05 FABRICATION**

- A. Fabricate in accordance with approved shop drawings and ANSI A250.8.
- B. Reinforce frames 4-feet or greater in width with 12-gauge formed steel channel stiffener welded into head. Install stiffener flush with top of frame.
- C. Weld astragal to door leaf before finishing.
- D. Reinforce and prepare for hardware in accordance with ANSI A250.8. Use hardware manufacturer's templates for hardware preparation.
- E. Weld mortar guards into frames to be grouted at hardware mortises.
- F. Provide single grouting access opening in frames to be set in masonry openings:
  - 1. Center opening in inside face of head.
  - 2. Provide flush-mounted plate cover attached with countersunk flathead screws to cover opening.
- G. Silencer Holes:
  - 1. Refer to Section 08 71 00 – Door Hardware for schedule.
  - 2. Provide three silencer holes in strike jamb of frames for single doors except as specified. Space holes equally along jamb.
  - 3. Provide two silencer holes in head of frames for double doors except as specified.
  - 4. Omit silencer holes in frames for exterior doors where self-adhesive weather-stripping is to be applied.
- H. Coordinate installation of security and surveillance equipment where required.
- I. Repair damage to zinc-coated materials with commercial zinc-rich priming paint.

## **2.06 FINISH**

- A. Prime finish in accordance with ANSI A250.8.
- B. Use lead- and chromate-free priming paint compatible with finish paint to be field applied.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with approved shop drawings, manufacturer's instructions, and ANSI A250.8.
- B. Install plumb, level, and in alignment with adjacent work.
- C. Fill frames installed in masonry openings with approved cementitious grout.
- D. Coordinate installation of security and surveillance equipment where required.
- E. Test and adjust door operation for proper operation.

### **3.02 GLAZING**

- A. Side Lites:
  - 1. Paint frame before glazing.
  - 2. Clean and dry frame and glass immediately before glazing.
  - 3. Dry glaze with continuous glazing gasket around glass perimeter.

### **3.03 CONTRACTOR FIELD QUALITY TESTING**

- A. Spray doors with water. Repair leakage as approved by COR.
- B. Inspect doors for light infiltration. Repair as approved by COR.

### **3.04 PAINTING**

- A. Paint installed doors and frames in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

**SECTION 08 33 20**  
**ROLL-UP DOORS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

1. ASTM A653/A653M-08                      Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 08 33 20-1, Approval Drawings and Data:

1. Shop drawings:
  - a. Show dimensions, materials, relationship to structure, mounting and anchorage details, and other fabrication and installation details.
  - b. Identify doors by Government designations on drawings.
2. Manufacturer's product data.
  - a. Include complete descriptions and specifications for materials, construction, features, and finishes.

C. RSN 08 33 20-2, Sample and Color Sample Kit:

1. Complete set of manufacturer's standard color samples, finish samples, and texture samples for selection of door color, finish, and texture. Color copies of these items are not acceptable and will be returned not approved.
2. Coordinate Roll-Up Door color, finish, and texture selection with Sections 04 22 10 – Reinforced Concrete Unit Masonry Assemblies, 07 41 13 – Preinsulated Metal Roof Panels, 07 42 13 – Preinsulated Metal Wall Panels, and 07 72 30 – Roof Hatches.

D. RSN 08 33 20-3, Certification:

1. Manufacturer's certification that doors meet specified performance requirements.

- E. RSN 08 33 20-4, Instructions:
1. Manufacturer's storage, handling, installation, and maintenance instructions.

#### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Store and handle at jobsite in accordance with manufacturer's instructions.

#### **1.05 EXTRA MATERIALS**

- A. Furnish one complete set of replacement weather-stripping and seals for each door.

### **PART 2 PRODUCTS**

#### **2.01 PERFORMANCE REQUIREMENTS**

- A. Windload: Provide doors capable of withstanding a 20 pounds-per-square-foot horizontal windload without deformation or damage to door and components.

#### **2.02 ROLL-UP DOORS**

- A. Electrically operated service door: Stormtite AP Model 627, manufactured by Overhead Door Corporation, 2501 South State Highway 121 Business, Suite 200, Lewisville, TX 75067, or equal, with the following essential characteristics:
1. Rolling insulated service door.
  2. Slats constructed of exterior and interior sheets of 24 gauge, minimum, galvanized sheet steel with ASTM A653, G90 zinc coating.
  3. Slat profile: Flat, insulated, type FIT-265.
  4. Operation: Electric motor operated, with chain hoist back-up:
    - a. Motor Operator:
      - 1) Minimum 3/4-horse-power.
      - 2) 460-volts, 3-phase.
      - 3) Activated by button station mounted adjacent to door.
      - 4) UL listed.
  5. Insulation: Foamed in place, CFC and HCFC-free polyurethane.
  6. R-value: 10 minimum.
  7. STC Rating: 21 minimum for installed system.
  8. Flame Spread and Smoke Index: Class A or 1.
  9. Hood: 24 gauge galvanized steel with waterproof baffle to control air infiltration.
  10. Anti-air infiltration package.

11. Cylinder lock.
12. Bottom sensing edge and photo eyes:
  - a. Automatically reverses door when device detects an obstruction during downward travel of door.
13. Mounting: As shown on drawings.
14. Weather-stripping: At head, jambs, and door bottom.

### **2.03 COLOR, FINISH, AND TEXTURE**

- A. Color, Finish, and Texture: Primed and painted steel. Manufacturer's standard options. To be determined by Government.
- B. Coating Thickness: 2 mils, minimum.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with approved shop drawings and manufacturer's instructions.
- B. Coordinate installation of security and surveillance equipment where required.
- C. Install plumb and in alignment with adjacent work.
- D. Securely anchor to structural framing.
- E. Test and adjust door operation for proper operation.

### **3.02 MAINTENANCE**

- A. Maintain doors in accordance with manufacturer's instructions until acceptance of work by Government.

**END OF SECTION**

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**SECTION 08 51 20**  
**STEEL WINDOWS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

1. ASTM C1048 - 12 Heat-Strengthened and Fully Tempered Flat Glass
2. ASTM C1172 - 09 Laminated Architectural Flat Glass
3. ASTM E2190 - 10 Insulating Glass Unit Performance and Evaluation

B. Steel Door Institute (SDI)

1. SDI A250.8-2003(2008) Standard Steel Doors and Frames

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 08 51 20-1, Approval Drawings and Data:

1. Manufacturer's shop drawings:
  - a. Show dimensions, material gauges, glazing details, anchorage details, and other fabrication and installation details.
  - b. Identify windows by Government designations on drawings.
2. Manufacturer's product data:
  - a. Include complete descriptions and specifications for frame materials, construction, glass materials, glazing gasket, and finish.

**1.04 DELIVERY, STORAGE, AND HANDLING**

A. Permanently mark tempered glass in accordance with ASTM C1048.

B. Permanently mark insulating glass units on spacer or one insulating unit component with appropriate certification label of inspection and testing agency.

- C. Store window frames off ground, under cover, and protected from contact with moisture.

## **PART 2 PRODUCTS**

### **2.01 HOLLOW STEEL FRAMES**

- A. SDI A250.8, face welded type.
- B. Thickness: 18 gauge, minimum.
- C. Operation: Fixed.
- D. Coordinate with Steel Door Frame at Control Room, See Section 08 11 10 – Steel Doors and Frames.

### **2.02 INSULATING GLASS UNITS**

- A. Unit Thickness: 1-inch.
- B. Construction:
  - 1. Two lites of specified glass hermetically sealed to a desiccant-filled aluminum spacer.
  - 2. Dual seal consisting of polyisobutylene primary seal and organic or silicone secondary seal.
  - 3. Breather tube as required for changes in atmospheric pressure between point of manufacture and jobsite.
- C. Outboard Glass Lite – Laminated Fully Tempered:
  - 1. ASTM C1048, ASTM C1172, Kind FT, Condition C, Type I, Class 1, Quality Q3.
  - 2. Thickness: 1/4-inch.
- D. Inboard Glass Lite – Fully Tempered:
  - 1. ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3.
  - 2. Thickness: 1/4-inch.
- E. Certification: Tested in accordance with ASTM E2190 and certified by Insulating Glass Certification Council.

### **2.03 GLAZING MATERIALS**

- A. Glazing Gasket: Resilient, non-hardening, elastomeric glazing gasket.

**2.04 ACCESSORIES**

- A. Frame Anchors: ANSI A250.8.
- B. Glazing Stops:
  - 1. Same material as frame.
  - 2. Removable.
  - 3. Attached with flush-mounted screws.

**2.05 FABRICATION**

- A. Fabricate in accordance with approved shop drawings and ANSI A250.8.

**2.06 FINISH**

- A. Prime finish in accordance with ANSI A250.8.
- B. Use lead- and chromate-free priming paint compatible with finish paint to be field applied.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Install in accordance with approved shop drawings.
- B. Install plumb, level, and in alignment with adjacent work.
- C. Securely anchor frame to support system of wall.

**3.02 GLAZING**

- A. Paint frames before glazing.
- B. Clean and dry frame and glass immediately before glazing.
- C. Dry glaze with continuous glazing gasket around glass perimeter.

**3.03 CLEANING**

- A. Clean frame and glass surfaces after installation and glazing.
- B. Remove temporary labels from glass.

### **3.04 PAINTING**

- A. Paint installed window frames and glazing stops in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

**SECTION 08 62 00**  
**UNIT SKYLIGHTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |                    |  |
|----|--------------------|--|
| 1. | ASTM E283-04(2012) | Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| 2. | ASTM E331          | Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference                        |

B. Code of Federal Regulations (CFR):

- |    |                      |                          |
|----|----------------------|--------------------------|
| 1. | 29 CFR 1910.23(e)(8) | Walking-Working Surfaces |
|----|----------------------|--------------------------|

C. National Fenestration Rating Council (NFRC)

- |    |          |  |
|----|----------|--|
| 1. | NFRC 100 | Procedure for Determining Fenestration Product U-Factors   |
| 2. | NFRC 200 | Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence |

**1.03 PERFORMANCE REQUIREMENTS**

A. Performance-Test-Response Characteristics:

1. Air leakage: Maximum of 0.03 CFM/ft<sup>2</sup> of total unit area, measured at a differential pressure of 75 Pa (1.57 psf).
2. Water infiltration: No water penetration with a test pressure differential of 720 Pa (15.0 psf).
3. Thermal Performance: U-factor = 0.50 or less, SHGC = 0.40 or less and Vt = 0.65 or less. Tested and certified in accordance with NFRC 100 and 200 procedures.
4. Complies with 29 CFR 1910.23(e)(8).

## **1.04 SUBMITTALS**

- A. Submit the following accordance with Section 01 33 00 – Submittals.
- B. RSN 08 62 00-1, Approval Drawings and Data:
  - 1. Manufacturer's shop drawings:
    - a. Show layout, dimensions, relationship to roof system, fastening, and installation details.
  - 2. Manufacturer's product data:
    - a. Include complete descriptions and specifications for materials and construction.
- C. RSN 08 62 00-2, Instructions:
  - 1. Manufacturer's storage, handling, and installation instructions.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Store and handle at jobsite in accordance with manufacturer's instructions.

## **PART 2 PRODUCTS**

### **2.01 UNIT SKYLIGHTS**

- A. Fixed Curb Mounted (FCM) Commercial Skylight manufactured by VELUX America Incorporated, 450 Old Brickyard Road, Greenwood, SC 29648; or equal, having following essential characteristics:
  - 1. Fixed unit skylight mounted on prefabricated or site-built curbs.
  - 2. 22 1/2-inch width by 70 1/2-inch length inside curb clearance.
  - 3. Tempered LoE<sup>3</sup> pane over a laminated heat strengthened interior pane with 0.030-inch white interlayer.
  - 4. Fabricated one piece aluminum counter flashing system with corner keys.
  - 5. Provide internal drainage of glazing spaces with exterior through gaskets to remove condensation.
  - 6. Factory glazed with structural silicone-based primary seal.
  - 7. Maintenance-free roll-formed aluminum frame with neutral gray Kynar 500 polyvinylidene fluoride resin finish.
  - 8. Roll-formed aluminum, neutral gray, baked on polyester polyamide primer and finish coats.

**2.02 ACCESSORIES**

- A. Engineered, prefabricated gutter system designed for use with high profile roofing materials, and for slopes 0 to 60 degrees.
- B. Custom flashing provided by others where applications of prefabricated flashing are not suitable.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Install in accordance with approved shop drawings and manufacturer's instructions.
- B. Incorporate into building roof system, counterflash, and seal installation in accordance with drawings and 07 41 13 – Preinsulated Metal Roof Panels.
- C. Prevent galvanic action between aluminum and dissimilar metals by methods recommended by skylight manufacturer.
- D. Make installation waterproof and weathertight.

**3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Spray skylight with water. Repair leakage as approved by COR.

**3.03 CLEANING**

- A. Clean exposed surfaces using methods recommended by manufacturer.

**END OF SECTION**

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**SECTION 08 71 00**  
**DOOR HARDWARE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. Builders Hardware Manufacturers Association (BHMA)

- |    |                 |                                      |
|----|-----------------|--------------------------------------|
| 1. | BHMA A156.1-16  | Butts and Hinges                     |
| 2. | BHMA A156.3-14  | Exit Devices                         |
| 3. | BHMA A156.4-19  | Door Controls - Closers              |
| 4. | BHMA A156.6-15  | Architectural Door Trim              |
| 5. | BHMA A156.13-17 | Mortise Locks and Latches            |
| 6. | BHMA A156.16-18 | Auxiliary Hardware                   |
| 7. | BHMA A156.21-14 | Thresholds                           |
| 8. | BHMA A156.22-17 | Door Gasketing and Edge Seal Systems |

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 08 71 00-1, Hardware Schedule and Approval Data:

1. Contractor's hardware schedule:
  - a. Include complete hardware group, door, handing, hardware, accessories, and finish identification.
  - b. Use Government designations to identify doors and hardware groups.
2. Manufacturer's product data.

C. RSN 08 71 00-2, Instructions:

1. Manufacturer's installation instructions.

**1.04 SEQUENCING**

Do not install surface-mounted hardware, gasketing systems, or weather-stripping on steel doors and frames until doors and frames have been painted.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Label each hardware container with item number in approved hardware schedule.

## **PART 2 PRODUCTS**

### **2.01 BASIC HARDWARE REQUIREMENTS**

- A. Single Source Requirement: Provide matching products from single manufacturer for each type of hardware.
- B. Materials and Finish: Stainless steel, BHMA 630-US32D, unless noted otherwise in the specifications or drawings or authorized by COR.
- C. Exit Devices: Listed by UL for accident hazard installations.
- D. Designated fire rated doors and associated hardware and accessories shall be UL fire rated.
- E. Templates: Provide manufacturers' templates for door and frame preparation.
- F. Coordinate with Section 28 10 01 – Security and Surveillance System:
  - 1. Provide electromechanical door hardware where required to integrate with card readers and keypads.
  - 2. Electromechanical hardware shall still require mortise locksets that can be used to unlock door in lieu of unlocking door through access control system specified in Section 28 10 91 – Security and Surveillance System.
  - 3. Doors with electromechanical door hardware shall be provided with mortise exit devices that allow personnel exit through door without requiring use of exit sensors or any operation from Access Control System in Section 28 10 01 – Security and Surveillance System.
  - 4. Provide all accessory components required for complete installation, including any required electrified hinges, or components associated with installation of Access Control System components.

### **2.02 BUTT HINGES**

- A. Heavy-Weight Stainless Steel Butt Hinges: BHMA A156.1, A5111, 4 1/2-inch by 4 1/2-inch, full mortise template hinge with five knuckles, four ball bearings, non-rising pin, and flat button tips.

### **2.03 LOCKSETS AND LATCHES**

- A. Type, Series, and Grade: BHMA A156.13, Series 1000, Grade 1, mortise locksets and latches.

- B. Front: Armored.
- C. Case: Wrought steel with zinc dichromate corrosion protection.
- D. Latch Bolt: 3/4-inch throw, anti-friction, deadlocking stainless steel bolt.
- E. Deadbolt: 1-inch throw, solid stainless-steel bolt with two enclosed hardened steel roller pins.
- F. Trim Installation: Self-aligning installation secured with thru-bolts from inside trim.
- G. Trim:
  - 1. Round rose and lever handle on inside and outside.
  - 2. Round lever handle with end return.
  - 3. Base Material:
    - a. BHMA 630-US32D finish: Stainless-steel.

## **2.04 DOOR CLOSERS**

- A. BHMA A156.4, Grade 1, Surface Closer - Modern Type with Cover, Option PT 4A, Option PT 4D, adjustable latching speed, multi-size spring power adjustable from size 2 through 6, non-handed arm, and corrosion inhibiting prime coat or pre-treatment.

## **2.05 EXIT DEVICES**

- A. Mortise Exit Devices: Falcon 25-M Series exit device manufactured by Allegion: or equal, having the following essential characteristics:
  - 1. Meets requirements of BHMA A156.3, Grade 1.
  - 2. Mortise latch.
  - 3. 3/4-inch throw, action friction, deadlocking latch bolt.
- B. Surface-Mounted Vertical Rod Exit Devices: Falcon 25-V Series exit device manufactured by Allegion: or equal, having the following essential characteristics:
  - 1. Meets requirements of BHMA A156.3, Grade 1.
  - 2. Surface-mounted vertical rod latch bolt at top and bottom of door leaf.

## **2.06 FLUSH BOLTS**

- A. Lever Extension Flush Bolts:
  - 1. BHMA A156.16, with flat front and 12-inch length rod.

## **2.07 DOOR PLATES**

- A. Kick Plates: BHMA A156.6, J102, 12-inches height, stainless steel plate, 0.050-inch thick, with 3 beveled edges.

## **2.08 SILENCERS**

- A. BHMA A156.16, inserted-type rubber silencer.

## **2.09 GASKETING AND WEATHERSTRIPPING SYSTEMS**

- A. Head and Jamb Gasket Weather-stripping: S88 Series gasketing manufactured by Pemko or equal, having the following essential characteristics:
  - 1. BMHA A156.22.
  - 2. Compression bolt with stabilizer flange.
- B. Meeting Stiles Gasketing: 303\_S Series split astragal seals manufactured by Pemko or equal, having the following essential characteristics:
  - 1. BHMA A156.22.
  - 2. Extruded aluminum flange with vinyl bulb insert.
- C. Door Shoe with Drip Cap: 2221V Series manufactured by Pemko or equal, having the following essential characteristics:
  - 1. BHMA A156.22.
  - 2. One piece, channel-type, extruded aluminum housing with integral rain drip.
  - 3. One piece, removable, fingered vinyl insert seal.
  - 4. One half inch seal height.
- D. Door Show without Drip Cap: 222V Series manufactured by Pemko or equal, having the following essential characteristics:
  - 1. BHMA A156.22.
  - 2. One-piece, channel-type, extruded aluminum housing.
  - 3. One-piece, removable, fingered vinyl insert seal.
  - 4. One-half inch seal height.

## **2.10 THRESHOLDS**

- A. Saddle Thresholds: BMHA A156.21, extended aluminum with 1/4-inches height and 5-inches width.

## **2.11 ACCESSORIES**

- A. Strikes and Accessories: Provide matching strikes and accessories required for installation or operation of hardware.
- B. Fasteners: Matching fasteners suitable for application furnished by product manufacturer.

## **2.12 LOCK CYLINDERS AND KEYING**

- A. Furnish locks with seven-pin, interchangeable-core, lock cylinders:
  - 1. Furnish lock cylinders with temporary construction core system which can be voided after contract completion.
  - 2. Key locks alike.
- B. Furnish permanent core system after contract completion. Provide two keys per lock.
- C. Stamp construction keys with "U.S. Property - Do Not Duplicate" and appropriate key numbers.
- D. Furnish six construction keys to COR for Government's use during construction.
- E. Deliver construction keys to COR at jobsite after completion of work when directed by COR.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Mount hardware in accordance with approved shop drawings for doors and frames.
- C. Use manufacturer's templates for field mounting of hardware.
- D. Adjust operation of closers as recommended by manufacturer for door size, weight, movement, and jobsite conditions.
- E. Coordinate installation of security and surveillance equipment where required.
- F. Thresholds:
  - 1. Fit threshold to doorframe.
  - 2. Attach to concrete with machine screws in expansion anchors.
  - 3. Weathertight.

- G. Gasketing and Weather-stripping:
1. Install or apply in continuous lengths without joints.
  2. Butt corners tight.
  3. Provide effective door seal.
- H. Test door operation and correct defects in operation.

### 3.02 HARDWARE SCHEDULE

Table 08 71 00A - Door Hardware Schedule

Hardware Group No.	Door Numbers	Required Hardware for Each Door
1	002, 101, 102, 103, 105	Butt hinges: 1 1/2-pair. Lockset and Latch: F13-Dormitory or Exit Lock. Door closer: Parallel arm, non-hold-open. Exit device: Mortise. Kick plate: Interior face only. Gasketing and weather-stripping: Head and jamb gasket weather-stripping, door shoe with drip cap. Threshold.
2	001	Butt hinges: 1 1/2-pair per door. Lockset and Latch: F13-Dormitory or Exit Lock. Door closer: Parallel arm, non-hold-open, active door leaf only. Exit device: Mortise, active door leaf only. Flush bolts: Inactive door leaf only. Kick plate: Interior face only, both door leaves. Gasketing and weather-stripping: Head and jamb gasket weather-stripping, door shoe with drip cap both leaves. Threshold. Astragal: Standard welded steel, active leaf only (See Section 08 11 10 – Steel Doors and Frames)
3	107	Butt hinges: 1 1/2-pair per door. Lockset and Latch: F05-Classroom Lock (Vertical Rod). Door closer: Parallel arm, non-hold-open, both door leaves. Exit device: Vertical Rod, both door leaves. Kick plate: Both faces, both door leaves. Silencers. Gasketing and weather-stripping: Meeting stiles gasketing, door shoe without drip cap both leaves.

**END OF SECTION**

**SECTION 09 29 00**  
**GYPSUM BOARD**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |                      |  |
|----|----------------------|--|
| 1. | ASTM C473 - 12       | Physical Testing of Gypsum Panel Products  |
| 2. | ASTM C475/C475M - 12 | Joint Compound and Joint Tape for Finishing Gypsum Board   |
| 3. | ASTM C840 - 11       | Application and Finishing of Gypsum Board  |
| 4. | ASTM C954 - 11       | Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness |
| 5. | ASTM C1002 - 07      | Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs                                |
| 6. | ASTM C1047-10a       | Accessories for Gypsum Wallboard and Gypsum Veneer Base  |
| 7. | ASTM C1396/C1396M-11 | Gypsum Board   |
| 8. | ASTM C1629/C1629M-06 | Abuse-Resistant Non-decorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels  |
| 9. | ASTM D3273-00(2005)  | Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber   |

B. Gypsum Association (GA)

- |    |           |   |
|----|-----------|---|
| 1. | GA-214-10 | Recommended Levels of Gypsum Board Finish |
|----|-----------|---|

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 09 29 00-1, Approval Data:
  - 1. Manufacturer's product data for gypsum board and accessories.

### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle materials in accordance with ASTM C840 and manufacturer's recommendations.

### **1.05 SEQUENCING**

- A. Do not install board materials until work to be concealed by board has been completed and COR has inspected and accepted work.

### **1.06 ENVIRONMENTAL REQUIREMENTS**

- A. Maintain environmental conditions in accordance with ASTM C840.

## **PART 2 PRODUCTS**

### **2.01 GYPSUM BOARD**

- A. Hi-Impact XP Gypsum Board manufactured by National Gypsum Company, 2001 Rexford Road, Charlotte, NC 28211; Mold Tough AR Firecode Core manufactured by United States Gypsum Company, 550 West Adams Street, Chicago, IL 60661; or equal, having following essential characteristics:
  - 1. Meets requirements of ASTM C1396, Type X.
  - 2. Overall thickness: 5/8-inch.
  - 3. Moisture resistance: ASTM C473, average water absorption not greater than 5 percent by weight after two-hour immersion.
  - 4. Mold/mildew resistance: ASTM D3273, 10, minimum.
  - 5. Surface abrasion: ASTM C1629, Level 2, minimum.
  - 6. Surface indentation: ASTM C1629, Level 1, minimum.
  - 7. Tapered long edges.
  - 8. Plain face and plain back.

### **2.02 ACCESSORIES**

- A. Drywall Screws:

1. Type S: ASTM C1002, Type S, 3/8-inch, minimum, longer than total thickness of board to be penetrated.
  2. Type S-12: ASTM C954, 1/2-inch, minimum, longer than total thickness of board to be penetrated.
- B. Joint Compounds and Tapes:
1. ASTM C475.
  2. Materials recommended by gypsum board manufacturer for application and jobsite conditions.
  3. Use water-resistant materials for finishing gypsum board to be covered with ceramic tile.
- C. Cornerbead:
1. ASTM C1047, zinc-coated steel, with perforated flanges.
  2. Size recommended by gypsum board manufacturer for board thickness and application.
- D. Edge Trim:
1. ASTM C1047, U-Bead, zinc-coated steel.
  2. Size to match board thickness.
- E. Caulk: Paintable acrylic-latex sealant.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Gypsum Board:
1. Apply and finish in accordance with ASTM C840.
  2. Mechanically fasten to support systems with drywall screws in accordance with ASTM C840, System VIII.
  3. Use type S-12 screws for fastening to 20-gauge or heavier metal.
  4. Use type S screws for fastening to lighter gauge metal.
  5. Finish surfaces to be covered by ceramic tile with GA-214 Level 2 finish.
  6. Finish surfaces to be painted with GA-214 Level 4 finish.
- B. Joints: Construct and space in accordance with ASTM C840.
- C. Accessories:
1. Place cornerbead at external corners.

2. Place edge trim where gypsum board abuts dissimilar materials.
  3. Install in accordance with manufacturer's recommendations.
- D. Caulking:
1. Install in accordance with manufacturer's recommendations.
  2. Use backer rod and accessory materials recommended by manufacturer.
  3. Place and tool to smooth surface free of air pockets, embedded foreign material, ridges, and sags.

### **3.02 PAINTING**

- A. Paint exposed surfaces in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

**SECTION 09 65 10**  
**RUBBER WALL BASE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for Metal Building System.

**1.02 REFERENCE STANDARDS**

- A. ASTM International (ASTM)
1. ASTM F1861-08 (2012) Resilient Wall Base

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 09 65 10-1, Approval Data and Color Sample Kit:
1. Manufacturer's product data for base and adhesive.
  2. Manufacturer's color sample kit for color selection.
- C. RSN 09 65 10-2, Instructions:
1. Manufacturer's surface preparation and installation instructions for base and adhesive.

**1.04 SEQUENCING**

- A. Install base before wall surface is painted.

**PART 2 PRODUCTS**

**2.01 RUBBER WALL BASE**

- A. ASTM F1861, Type TV, Group 1, Style B - cove.
- B. Thickness: 1/8-inch.
- C. Height: 6-inches.

**2.02 ACCESSORIES**

- A. Corners: Matching factory-made molded corners.

- B. Adhesive: As recommended by base manufacturer for substrate surface.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Clean and dry wall surface in accordance with manufacturer's instructions.
- B. Prime substrate as recommended by adhesive manufacturer.

#### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install in maximum possible lengths to minimize joints.
- C. Butt joints tight without gaps or offset.
- D. Accurately scribe to doorframes and intersecting surfaces.
- E. Finish internal and external wall corners with molded corners.

**END OF SECTION**

**SECTION 09 96 20**  
**COATINGS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |     |                      |  |
|-----|----------------------|--|
| 1.  | ASTM A380-17         | Cleaning, Descaling, and Passivation of Stainless-Steel Parts, Equipment, and Systems        |
| 2.  | ASTM A780-09(2015)   | Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings                          |
| 3.  | ASTM C920-18         | Elastomeric Joint Sealants   |
| 4.  | ASTM D870-15         | Testing Water Resistance of Coatings Using Water Immersion                                   |
| 5.  | ASTM D2244-16        | Calculation of Color Differences from Instrumentally Measured Color Coordinates              |
| 6.  | ASTM D2794-93(2019)  | Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)                  |
| 7.  | ASTM D4060-19        | Abrasion Resistance of Organic Coatings by the Taber Abraser                                 |
| 8.  | ASTM D4138-07a(2017) | Measurement of Dry Film Thickness of Protective Coatings by Destructive, Cross Section Means |
| 9.  | ASTM D4259-18        | Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application       |
| 10. | ASTM D4263-83(2018)  | Indicting Moisture in Concrete by the Plastic Sheet Method                                   |
| 11. | ASTM D4414-95(2013)  | Measurement of Wet Film Thickness by Notch Gages   |
| 12. | ASTM D4285-83(2018)  | Indicating Oil or Water in Compressed Air  |

- |      |  |  |
|------|--|--|
| 13.  | ASTM D4541-17  | Pull-Off Strength of Coatings Using Portable Adhesion Testers  |
| 14.  | ASTM D4587-11  | Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water-Exposure Apparatus |
| 15.  | ASTM D5894-16  | Cyclic Salt Fog/UV Exposure of painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)             |
| 16.  | ASTM D6132-13(2017)                                  | Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Over Concrete Using an Ultrasonic Gage                  |
| 17.  | ASTM E95-68(2016)                                    | Cell-Type Oven with Controlled Rates of Ventilation  |
| 18.  | ASTM F1869-16a                                       | Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride   |
| 19.  | ASTM G8-96(2019)                                     | Cathodic Disbonding of Pipeline Coatings   |
| <br> |  |  |
| B.   | American Water Works Associations (AWWA)             |  |
| 1.   | AWWA D103-09   | Factory Coated Bolted Carbon Steel Tanks for Water Storage   |
| <br> |  |  |
| C.   | International Organization for Standardization (ISO) |  |
| 1.   | ISO 8502-3-2017                                      | Assessment of dust on Steel Surface Prepared for Painting (Pressure-Sensitive Tape Method)   |
| <br> |  |  |
| D.   | Master Painters Institute (MPI)                      |  |
| 1.   | Approved Product List (APL)                          | <a href="http://www.paintinfo.com">www.paintinfo.com</a> or <a href="http://www.mpi.net">www.mpi.net</a>                             |
| <br> |  |  |
| E.   | National Association of Pipe Fabricators (NAPF)      |  |
| 1.   | NAPF 500-03-04-06                                    | Abrasive Blast Cleaning of Ductile Iron Pipe   |
| 2.   | NAPF 500-03-05-06                                    | Abrasive Blast Cleaning of Cast Ductile Iron Fittings  |
| <br> |  |  |
| F.   | NSF International (NSF)                              |  |
| 1.   | NSF 61-2016  | Drinking Water System Components   |
| <br> |  |  |
| G.   | SAE International                                    |  |
| 1.   | SAE AMS-STD-595-17                                   | Colors Used in Government Procurement  |

- H. The Society for Protective Coatings (SSPC)/NACE International (NACE)
1. SSPC-AB1-19 Mineral and Slag Abrasives
  2. SSPC-AB2-16 Cleanliness of Recycled Ferrous Metallic Abrasives
  3. SSPC-AB3-17 Newly Manufactured or Re-Manufactured Steel Abrasives
  4. SSPC-PA1-16 Shop, Field, and Maintenance Painting of Steel
  5. SSPC-PA2-17 Measurement of Dry Paint Thickness with Magnetic Gages
  6. SSPC-QP1-15 Evaluating Painting Contractors (Field Application to Complex Industrial Structures)
  7. SSPC-QP3-10/AISC 420 Evaluating the Qualification of Shop Painting Contractors
  8. SSPC-SP1-16 Solvent Cleaning
  9. SSPC-SP3-18 Power Tool Cleaning
  10. SSPC-SP5/NACE 1-07 White Metal Blast Cleaning
  11. SSPC-SP10/NACE 2-07 Near-White Blast Cleaning
  12. SSPC-SP11-13 Power Tool Cleaning to Bare Metal
  13. SSPC-VIS1-12 Guide and Reference Photographs for Steel Surfaces Prepared by Abrasive Blast Cleaning
  14. SSPC-VIS3-07 Visual Standard for Power- and Hand-Tool Cleaned Steel
  15. NACE SP 0188-06 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
  16. NACE SP 0274-11 High Voltage Electrical Inspection of Pipeline Coatings
  17. NACE SP 0287-16 Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces

### 1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 09 96 20-1, Approval Data:

1. For each coating material:

- a. Manufacturer's product data, application, and SDS.
  - b. Supplier's name, address, and phone number.
  - c. Identification of "Items to be coated" including sub-letter and sub-number listed in Coating Tabulations.
  - d. Manufacturer's certification that material meets MPI specification requirements.
  - e. National Sanitation Foundation (NSF) 61 certificate for use in potable water.
2. For each caulk and filler:
    - a. Manufacturer's product data, application, and SDS.
    - b. Supplier's name, address, and phone number.
    - c. Identification of areas of use including sub-letter and sub-number listed in Coating Tabulations.
  3. For each substituted coating material "equal" to specified product in Coating Tabulation:
    - a. List of not less than 3 similar successful material applications:
      - 1) Project name, location, type of structure, and application dates.
      - 2) Owner's name, address, and telephone number.
    - b. Certification that material meets or exceeds specified requirements:
      - 1) Manufacturer's certification including technical representative's signature and date of signature.
      - 2) Independent laboratory's certified test reports.
- C. RSN 09 96 20-2, Final Approval Data:
1. For each coating material and thinner:
    - a. Purchase orders including order number, date, manufacturer's designated product name, batch number(s), and quantity purchased.
- D. RSN 09 96 20-3, Paint Chip Samples:
1. Color chip samples approximately 4-by 6-inch.
  2. Label each sample to include manufacturer's designated product name, color, and gloss.
  3. Color chip samples to be sent to COR for selection and approval.
- E. RSN 09 96 20-4, Qualifications:
1. Coating Contractor. Provide the following:
    - a. Current SSPC-QP1 and/or SSPC-QP3 certifications.

- b. List of not less than three comparable jobs for each coating type including owner's name, address, and telephone numbers.
- 2. Coating applicator qualifications:
    - a. Qualified to apply specified coating materials by coating experience or certifications. Provide one or more of the following:
      - 1) Current Coating Application Specialist (CAS) or Plural Component Application Certification (PCAC).
      - 2) Successfully completed training in application of coating materials similar too materials and conditions specified. Provide documentation.
      - 3) Letter from coatings manufacture/supplier that applicator is trained by the coating manufacture/supplier.
      - 4) List of not less than 3 comparable jobs for each coating type including owner's name, address, and telephone number.
  - 3. Coating Contractor Inspectors. Provide the following:
    - a. Letter from contractor listing the personnel performing QC inspections, certified at a minimum, as NACE Coatings inspector Level 1 or a SSPC Protective Coatings Inspector (PCI), as they report directly to a QC Supervisor who shall be a NACE Level 3 Coatings Inspector or a SSPC Protective Coatings Inspector (PCI).
- F. RSN 09 96 20-5, Quality Control Plan:
- 1. Quality Control Manager:
    - a. Name and title.
  - 2. Quality Control Procedure:
    - a. Quality control plan.
    - b. Procedure for addressing identified non-conformities.
- G. RSN 09 96 20-6, Contractor Quality Testing Report:
- 1. Comprehensive report of daily quality control test reports.

#### **1.04 DELIVERY, STORAGE, HANDLING**

- A. Deliver materials to jobsite in original, undamaged, unopened containers labeled with manufacturer's name, designated product name, batch number, date of manufacture, and any special instructions.
- B. Deliver materials in containers not larger than 5-gallons as packaged by manufacturer unless suitable equipment is provided at jobsite to handle and thoroughly mix materials in larger containers.

- C. Store coating materials and thinners in accordance with manufacturer's recommendations, and as minimum, store off ground, under cover, and at 50 to 95 degrees F.
- D. Do not use coating material which has exceeded manufacturer's specified storage stability period (shelf-life).

## **1.05 AMBIENT CONDITIONS**

- A. Maintain environmental conditions to meet coating manufacturer's requirements during surface preparation, coating application, and curing period. Provide heating or cooling, and dehumidification as needed. Complete curing before placing coating systems into service.
- B. Coatings shall be applied when substrate surface temperature is 5 degrees F or more above dew point temperature and for at least 8-hours after application.

## **PART 2 PRODUCTS**

### **2.01 EQUIPMENT**

- A. Surface preparation and spray application equipment:
  - 1. Sized in accordance with coating manufacturer's recommendations.
  - 2. Provide:
    - a. Pressure gauges and pressure regulators.
    - b. Air supply lines free from oil and moisture.

### **2.02 ABRASIVES**

- A. Mineral and slag abrasives: Meets SSPC-AB1, Type I (natural minerals) and Type II (slags), Class A.
- B. SSPC-AB2 for recycled cleanliness.
- C. SSPC-AB3 Class I (steel) or II (iron) for angular shaped grit. Shot abrasives are not acceptable.
- D. Commercially available products or processes to render hazardous waste stream non-hazardous and not exceeding toxicity threshold limits.

### **2.03 COATINGS**

- A. Specified in Coating Tabulations:
  - 1. Apply only one coating system per option in Coating Tabulations.
  - 2. Apply compatible products of same manufacturer for coating system components.

- B. Volatile Organic Compounds (VOC): Do not exceed maximum permitted by Federal, State, Tribal and local air pollution control regulations as supplied in container or by addition of thinner material.
- C. Factory color or tint only. Do not color or tint at jobsite.
- D. Use manufacturer's recommended thinners for coating materials.
- E. Do not use accelerator products unless approved by COR.

## **2.04 FILLERS AND CAULKS**

- A. Caulks:
  - 1. Coating manufacturer's standard or compatible caulk material.
  - 2. Polyurethane, silicone, or silicone acrylic caulk material: Meets or exceeds ASTM C920 Type S or M, Grade NS, Class 25, suitable for water immersion service.
- B. Fillers:
  - 1. Carboguard 501, as manufactured by Carboline, [www.carboline.com](http://www.carboline.com).
  - 2. Devmat 142HB, as manufactured by International Paint, [www.international-pc.com](http://www.international-pc.com).
  - 3. PPG Amercoat 114 A, as manufactured by PPG, [www.ppgpmc.com](http://www.ppgpmc.com).
  - 4. Steel Seam FT910, as manufactured by Sherwin Williams, [www.sherwin-williams.com](http://www.sherwin-williams.com).
  - 5. Surfacing Epoxy Series 215 was manufactured by Tnemec, [www.tnemec.com](http://www.tnemec.com).
  - 6. Provide one of the above fillers, or equal with following essential characteristics:
    - a. Coating manufacturer's standard filler material.
    - b. Approved use by manufacturer.

## **PART 3 EXECUTION**

### **3.01 PROTECTION OF ADJACENT SURFACES**

- A. Remove, mask, or otherwise protect items or surfaces not coated from contamination and damage during cleaning and coating operations.
- B. Examples include protecting mating and machined surfaces, mechanical and electrical equipment (open or enclosed), instruction and similar plates, and wet and newly coated surfaces.

### **3.02 COATING OF METALWORK EMBEDDED IN CONCRETE**

- A. For atmospheric exposure on both sides of embedded concrete or when mechanical bond is needed:
  - 1. Penetrations through concrete: Extend prime coat on steel 6-inches minimum into concrete embedment measured from face of concrete and along surface of embedded.
  - 2. Examples include: above ground thrust or anchor blocks, floors, and walls with pipe or metal passing through concrete.
- B. For burial or immersion service exposure on either side of concrete faces:
  - 1. Extend primer coat continuously through solid concrete structure.
  - 2. Examples include: Sill plates, anchor plates.
- C. Caulk concrete/steel interface to seal gaps at exposed faces in accordance with manufacturer's instructions with maximum thickness of 1/2-inch.

### **3.03 SURFACE PREPARATION – FERROUS SURFACES**

- A. See Coating Tabulations:
- B. Remove or repair surface irregularities and impart profile as specified:
  - 1. Welds:
    - a. Welds: Smooth and continuous.
    - b. Weld spatter, slag, buckshot, laminations, and slivers: remove and grind smooth.
    - c. Undercuts and porosity: Fill with weld material and grind smooth.
    - d. Projections, sharp edges, high points, fillets, and corners: Grind smooth to a radius of at least 1/16-inch.
  - 2. Substrate defects:
    - a. Pitting, gouges, scratches, porosity, and similar:
      - 1) Grind smooth.
      - 2) Defects exceeding 20 percent reduction in wall thickness require weld repairs.
  - 3. Grind full length of edges and corners smooth to radius of at least 1/16-inch.
- C. Surface preparation method:
  - 1. For Ferrous Surfaces:
    - a. Method A: SSPC-SP1.
    - b. Method B: SSPC-SP6/NACE 3.

- c. Methods B-1:
  - 1) Repair of defective or damaged coated areas.
  - 2) For metal substrate:
    - a) SSPC-SP6/NACE 3.
    - b) SSPC-SP11 where abrasive blasting is impractical.
  - 3) For surrounding intact coating:
    - a) Nominal 2- to 4-inch margin.
    - b) SSPC-SP1.
    - c) Feather abrupt edges and around repair area by hand or power tool with non-woven pad into adjacent tightly bonded coatings.
    - d) Roughen or abrade surface in accordance with manufacturer's recommendations to achieve matted or lusterless finish.
    - e) SSPC-SP1.
- d. Method C: SSPC-SP10/NACE 2.
- e. Method C-1: Repair of defective or damaged coated areas:
  - 1) For metal substrate:
    - a) SSPC-SP10/NACE 2.
    - b) SSPC-SP11 where abrasive blasting is impractical.
  - 2) For surrounding intact coating (nominal 2- to 4-inch margin):
    - a) SSPC-SP1.
    - b) Feather abrupt edges and around repair area by hand or power tool with non-woven pad into adjacent tightly bonded coatings.
    - c) Roughen or abrade surface in accordance with manufacturer's recommendations to achieve matted or lusterless finish.
    - d) SSPC-SP1.
- f. Method F (cast iron): NAPF 500-03-05, Blast Clean No. 4.
- g. Method F1 (ductile iron pipe): NAPF 500-03-04.
- h. Method H: SSPC-SP5/NACE 1.

### 3.04 SURFACE PRERPARATION – CONCRETE AND GYPSUM BOARD

#### A. Concrete and Masonry:

1. Curing: Concrete, stucco and masonry surfaces shall be allowed to cure at least 28-days before painting, except concrete slab on grade, which shall be allowed to cure 90-days before painting. Before coating application, repair cementitious defects greater than 3/4-inch in depth by one of following:
  - a. In accordance with manufacturer's product instructions.
2. Surface cleanliness: Free of dirt, dust, grease, oil, laitance, efflorescence, form oil, and curing compounds.
3. Surface irregularities for concrete: After surface preparation, repair following surface irregularities:
  - a. Air pockets (bugholes): Repair bugholes greater than 1/8-inch in diameter by adhesive epoxy or manufacturer's repair compound filler.
  - b. Protrusions, fins, or bulges: Grind down by SSPC-SP13/NACE 6 surface preparation methods to 1/16-inch or less of surrounding surface.
  - c. Cracks: Repair cracks with material compatible with manufacturer's coating material listed in Coating Tabulations.
4. Moisture content for concrete: Do not apply coatings to damp surfaces as determined by ASTM D4263 and/or to horizontal surfaces that exceed 3 pounds of moisture per 1,000 square feet in 24-hours as determined by ASTM F1869. In all cases follow manufacturer's recommendations:
  - a. Test substrate surface for moisture content before applying coating.
  - b. Perform one test per 1,000 square feet, minimum.

#### B. Perform tests in accordance with moisture content inspection procedures specified and coating manufacturer allowable moisture content:

1. See Coating Tabulations:
  - a. Method T (concrete and masonry): SSPC-SP13/NACE 6, except as specified:
    - 1) Section 4.3.3: Fractures and micro-cracks caused by impact tools are to be repaired in accordance with ASTM D4259.
    - 2) Following methods are not permitted:
      - a) Section 4.3.3: Scabbling impact tool.
      - b) Section 4.4: Chemical surface preparation.
      - c) Section 4.5: Flame (Thermal) cleaning and blasting.

- 3) Contaminants: Remove all dirt, loose mortar and spatter, residues, powder, oil and grease, old paint (i.e. and foreign matter):
    - a) Oil and grease should be removed by TSP wash and in some cases solvent cleaning can be used, followed by through rinsing with clean water.
    - b) All loose material should be removed by wire brushing, power washing, or abrasive blasting (sweep blast).
  - 4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on surface for more than 5-minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.
- b. Method U (gypsum board, plaster, stucco):
- 1) Repair cracks and other surface imperfections with joint finishing compound in accordance manufacturer's instructions.
  - 2) Remove all dirt, dust, and foreign matter with clean, lint-free, wiping material before coating application.
  - 3) Surface Cleaning: Plaster and stucco shall be clean and free from loose matter; gypsum board shall be dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of first coat material. Damp cloth or sponge may be used if paint will be water-based.
  - 4) Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.
  - 5) Exposed nails, screws, fasteners, and miscellaneous ferrous surfaces are to be spot prime before application of paint system.
2. Compare prepared steel surfaces to following visual reference photographs for allowable visible contaminants and stains:
- a. SSPC-VIS1 for abrasive blast cleaning.
  - b. SSPC-VIS3 for power and hand tool cleaning.
3. Assessment of dust contaminants:
- a. Perform clear tape test method in accordance with ISO 8502-3.
  - b. Perform three tests per shift.
  - c. Acceptance Criteria: Degree of cleanliness shall meet Class 2.
- C. Surface profile:
1. Prepare as specified in Coating Tabulations.

2. Where not specified, prepare in accordance with manufacturer's instructions for metallic substrates or existing coating surfaces and service environment.
  3. Where manufacturer's instructions do not specify surface profile, prepare blasted surfaces to following profile:
    - a. Atmospheric Service Environments: 1 mil or greater angular profile and less than specified millage of first applied coat.
    - b. Burial and Immersion Service Environments: Angular profile 2 mil or greater and less than specified millage of first applied coat.
  4. Inspect surface profile in accordance with NACE SP 0287:
    - a. Use replica tape suitable for surface profile depth range.
    - b. Perform at least two tests per 1,000 square feet.
- D. Re-clean or perform additional surface preparation of contaminated surfaces before coating application.
- E. Heat cast iron components to between 140- and 180-degrees F to evaporate moisture for 2-hours minimum.

### **3.05 COMPRESSED AIR EQUIPMENT**

- A. Keep air compressor and spray application equipment lines free of oil and moisture during work.
- B. Compressed air quality:
1. Perform tests in accordance with ASTM D4285.
  2. Perform test at beginning of every shift.

### **3.06 FILLERS AND CAULK APPLICATION**

- A. Caulk areas including crevices, gaps, plate seams, skip welds, and conduit penetrations.
- B. Fill areas including, plate seams, and gaps at bolts and rivets.
- C. Apply in uniform texture, neatness, and color matched appearance.
- D. Apply in accordance with manufacturer's instructions and achieve tight bond to substrate or previous coats.

### **3.07 COATING APPLICATION**

- A. Stripe coat:
1. Brush apply stripe coat.
  2. Apply stripe coat prior to spray application of the primer, when practical.
  3. Apply to edges, corners, interior angles, pits, plate seams, crevices, rivets, nuts, threads, bolts, washers, welds, and similar features.

- B. Apply number of coats and coating thickness specified in Coating Tabulations:
  - 1. Alternate coat colors to differentiate between coats.
  - 2. Apply in accordance with manufacturer's instructions.
  - 3. Apply in accordance with SSPC PA1.
- C. Prevent overspray or dry spray. When such conditions occur, clean surfaces prior to application of subsequent coats.
- D. Re-clean contaminated surfaces between coats.
- E. Dry Film Thickness (DFT):
  - 1. After each coat, inspect hardened coating system for DFT compliance in accordance with SSPC PA2.
  - 2. Acceptance Criteria: No single spot measurement less than 80 percent minimum or in excess of 120 percent maximum specified.
- F. Discontinuity (Holiday) Testing:
  - 1. Inspect in accordance with NACE SP 0188:
    - a. Use maximum test voltage for DFT as recommended by coating manufacturer to prevent coating damage.
  - 2. Inspect pipeline coatings in accordance with NACE SP 0274:
    - a. Use maximum test voltage for any DFT as recommended by coating manufacturer to prevent coating damage.
- G. Coating Adhesion:
  - 1. Test in accordance with ASTM D4541 at direction of COR.

### **3.08 CONTRACTOR FIELD QUALITY TESTING**

- A. Inspection Equipment:
  - 1. Calibrate inspection devices and equipment in accordance with manufacturer's instructions.
  - 2. Verify calibration prior to every use.
- B. Qualified personnel shall conduct tests and sign reports:
  - 1. Perform tests in presence of COR:
  - 2. Provide rigging for COR to observe inspections.
- C. Make daily reports for review by COR, including:
  - 1. Date of work.
  - 2. Description of areas and work performed.

3. Environmental conditions.
4. Results from the following quality control tests:
  - a. Surface profile.
  - b. Visual comparison of prepared surfaces.
  - c. Assessment of dust contaminants.
  - d. Compressed air quality.
  - e. Dry film thickness (DFT).
  - f. Discontinuity (Holiday) testing.
  - g. Concrete moisture content.
  - h. Moisture content:
    - 1) Method 1:
      - a) ASTM D4263.
      - b) Acceptance Criteria: No visible moisture.
    - 2) Method 2:
      - a) ASTM F1869.
      - b) Acceptance Criteria: Not to exceed 3 pounds of water per 1,000 square feet per 24-hours.
    - 3) Method 3:
      - a) Moisture meter calibrated to manufacturer's recommendation.
      - b) Acceptance Criteria: Not to exceed coating manufacturer's maximum recommendation for moisture content.
  - i. Wet Film Thickness (WFT) Testing for Concrete:
    - 1) Inspect wet film thickness immediately after application in accordance with ASTM D4414.
    - 2) Compensate for reduced thickness to achieve specified thickness in Coating Tabulations.
  - j. Dry film thickness (DFT), in accordance with SSPC-PA2:
    - 1) ASTM D4138.
    - 2) ASTM D6132.
  - k. Coating adhesion testing (when directed by COR).
- D. Final inspection will take place after repairs, but before placing into service.

### 3.09 REPAIR AND REMEDIAL WORK

- A. Repair defective or damaged areas of coatings in accordance with coating manufacturer's recommendations.

### 3.10 COATING TABULATIONS

Tabulation No. 1
<p>Items to be coated – Commercial or manufacturer's product with standard applied coating system:</p> <ul style="list-style-type: none"> <li>a. Air compressors.</li> <li>b. Air valve assemblies.</li> <li>c. Chlorine sampling tank.</li> <li>d. Electrical equipment, cabinets, and enclosures.</li> <li>e. Engine generator set equipment, vaporizer, weather protective housing, su-base fuel tank, fuel piping, and associated equipment.</li> <li>f. Fall arrest systems.</li> <li>g. Flowmeters.</li> <li>h. Medium Voltage switch gear.</li> <li>i. Motor control center and I/O cabinets.</li> <li>j. Pre-insulated metal wall and roof panels.</li> <li>k. Pre-insulated metal roof hatches and removable roof covers.</li> <li>l. Propane and fuel lines.</li> <li>m. Pump motors.</li> <li>n. Building roof access ladders.</li> <li>o. Sump pumps.</li> <li>p. Valve actuators and motor operators.</li> <li>q. Fire Extinguisher's.</li> </ul>
<p>Manufactures Standard Finish, Factory Finish or Shop Applied Permanent Coating System:</p> <ul style="list-style-type: none"> <li>1. Commercial or manufacturer's standard surface preparation and permanent coating system for intended installation locations.</li> <li>2. Items subject to sunlight shall be top-coated with ultraviolet (UV) stable materials.</li> <li>3. Permanent coating system shall have 8-year corrosion-free protection without significant defects stored in atmospheric exposure.</li> <li>4. Color and gloss: Standard color unless specific color is otherwise specified in color schedule.</li> <li>5. Unless otherwise specified, unexposed surfaces that require coatings, such as interior of cabinets, enclosures, and equipment, shall be given manufacturer's standard permanent coated finish.</li> </ul>
<p>Field Repair: Repair damaged areas of coated surfaces with compatible materials to equal thickness and color match of undamaged areas, unless otherwise tabulated herein.</p>

Tabulation No. 2
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Items to be coated:
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|---|
| <ul style="list-style-type: none"> <li>a. Guard posts. Coat safety yellow and gloss.</li> <li>b. Louvers and vent-covers.</li> <li>c. Metal surfaces of doors, doorframes, and door shoes.</li> <li>d. Roof access ladders that do not have manufacturer's standard finish.</li> <li>e. Structural steel and fasteners on the buildings.</li> </ul> |
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Coating Methods Options:
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- |  |
|--|
| <ol style="list-style-type: none"> <li>1. Commercial components shall be coated with manufacturer's standard surface preparation and applied permanent coating system that meets the following:             <ol style="list-style-type: none"> <li>a. 8-year corrosion-free protection without significant defects stored in atmospheric exposure.</li> <li>b. Color and gloss shall be manufacturer's standard unless specified below or in color schedule.</li> <li>c. Unexposed interior surfaces of cabinets, enclosures, and equipment shall be given manufacturer's standard permanent coated finish.</li> </ol> </li> <li>2. Shop or field coating to meet one or more of following application alternatives:             <ol style="list-style-type: none"> <li>a. Alternative 1 – Baked-on, coil, extrusion, or fusion bonded that consists of 1 or more coats of UV stable system.</li> <li>b. Alternative 2 – Complete shop applied permanent coating system that consists of 1-prime coat and 2-finish coats for Alkyds and Acrylics, or 1-prime coat and 1-finish coat for Epoxy/Polyurethanes.</li> <li>c. Alternative 3 – Shop applied primer and field finish coating system that consists of 2-mil DFT primer, minimum, with 2-field coats compatible with shop applied primer as specified below in coating material options.</li> </ol> </li> <li>3. Repair damaged areas with same shop applied primer and finish coat materials or compatible materials.</li> </ol> |
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Notes:
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| <ol style="list-style-type: none"> <li>1. Coating galvanized steel with an alkyd/silicone alkyd system requires compatible primer recommended by coating manufacturer.</li> <li>2. The following pre-surface preparations shall be performed by galvanizing-shop if galvanizing is to be coated:             <ol style="list-style-type: none"> <li>a. After metalwork has been galvanized and before applying coatings, remove zinc oxides by one of following:                 <ol style="list-style-type: none"> <li>(1) Acidic acrylic passivation solution.</li> <li>(2) Phosphate quenching.</li> <li>(3) Sweep blasting.</li> <li>(4) Wash primer.</li> </ol> </li> <li>b. After removal of zinc oxides on galvanized surface, repair small damaged galvanized areas with zinc-rich coating compatible with selected finish coat; except that zinc-rich</li> </ol> </li> </ol> |
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Tabulation No. 2		
<p>coatings are not permitted if phosphate quenching method is used. Dry film thickness shall be equal to galvanized nominal thickness.</p> <ol style="list-style-type: none"> <li>Remove stabilizing or storage treatments on galvanized metalwork by one of following:               <ol style="list-style-type: none"> <li>SSPC-SP1 and sweep blasting</li> <li>Manufacturer's compatible wash treatment.</li> </ol> </li> <li>Stainless-steel, aluminum, brass, and non-metallic parts need not be painted.</li> </ol>		
Coating Materials – Option 1 Alkyd/Silicone Alkyd	Number and Thickness of Coats	Surface Preparation Method
<p>Prime or spot repair coats:</p> <p>Carboline: Carbocoat 115 VOC/ Carbocoat 30R</p> <p>International Paint: Devguard 4160/ Devshield 877</p> <p>PPG: KL6040/ KLF Series Silicone Alkyd</p> <p>Sherwin Williams: Kem Kromik Universal Primer/ Steel Master 9500</p> <p>Tnemec: Chem-Prime HS Series 37H/ Versatone Series 82HS</p> <p>Color and gloss: See Color Schedule</p>	<p>1 or more prime coats apply at 2 to 3 mils DFT per coat, plus stripe coats.</p> <p>2 or more finish coats apply at 2 to 3 mils DFT per coat.</p> <p>Total system excluding stripe coats: 6-mil DFT, minimum 9-mil DFT, maximum</p>	<p>Undamaged coated surfaces to receive additional coats use Method A followed by:</p> <p>Uncoated surfaces: Method B</p> <p>Damaged coated surfaces: Method B-1 where abrasive blasting is impractical.</p> <p>Follow manufacturer's surface preparation instructions and application instructions to apply subsequent coats.</p>
Coating Materials – Option 2 Waterborne Acrylic	Number and Thickness of Coats	Surface Preparation Method
<p>Prime or spot repair:</p> <p>Carboline: Carbocrylic 3358/ Carbocrylic 3359</p>	<p>1 or more prime coats apply at 2 to 3 mils DFT per coat, plus stripe coats.</p> <p>2 or more finish coats apply at 2 to 3 mils DFT per coat.</p>	<p>Undamaged coated surfaces to receive additional coats use Method A followed by:</p> <p>Uncoated surfaces: Method B</p>

Tabulation No. 2		
<p>International Paint: Devflex 4020PF DTM/ Devflex 4216HP</p> <p>Sherwin Williams: Pro-Industrial Procryl Universal Acrylic Primer series B66-W00310/Pro- Industrial Procryl DTM Acrylic. Color and gloss: See Color Schedule</p>	<p>Total system excluding stripe coats: 6-mil DFT, minimum 9-mil DFT, maximum</p>	<p>Damaged coated surfaces: Method B-1 where abrasive blasting is impractical.</p> <p>Galvanizing: SSPC-SP7, SSPC-SP3, or manufacturer's chemical treatment. Follow manufacturer's surface preparation instructions and application instructions to apply subsequent coats.</p>
Coating Materials – Option 3 Epoxy/Polyurethane	Number and Thickness of Coats	Surface Preparation Method
<p>Carboline: Carboguard 691/ Carbothane 134 HB, HG, or VOC</p> <p>International Paint: Intergard 475HS/Interthane 870 UHS</p> <p>PPG: Amerlock 2 or 400/ Amercoat 450H or Amershield VOC</p> <p>Sherwin Williams: Duraplate 235 or Macropoxy 646/ Hi solids polyurethane or 250</p> <p>Tnemec: Epoxoline Series N69 or V69/ Endura-shield 1075</p> <p>Color and gloss: See Color Schedule</p>	<p>1 or more prime coats apply at 4 to 6 mils DFT per coat, plus stripe coats.</p> <p>1 or more finish coats apply at 3 to 4 mils DFT per coat.</p> <p>Total system excluding stripe coats: 7-mil DFT, minimum 10-mil DFT, maximum</p>	<p>Undamaged coated surfaces to receive additional coats use Method A followed by:</p> <p>Uncoated surfaces: Method B</p> <p>Damaged coated surfaces: Method B-1 where abrasive blasting is impractical.</p> <p>Follow manufacturer's surface preparation and application instructions to apply subsequent coats.</p>
<b>PERFORMANCE REQUIREMENTS:</b>		
Testing Protocol	Acceptance Criteria	

Tabulation No. 2	
Abrasion resistance, ASTM D4060, CS-17 wheel, 1,000 cycles, 1-kg load:	Alkyd or Acrylic: 250 milligram loss or less Epoxy/Polyurethane: 100 milligram loss or less
Direct impact, ASTM D2794:	40 inch-pounds for alkyd/silicone alkyd 140 inch-pounds for waterborne acrylics 30 inch-pounds for epoxy/polyurethane:
Pulloff adhesion, ASTM D4541, annex A2, type II tester:	250 psi or greater for alkyd/silicone alkyd 500 psi or greater for waterborne acrylics 800 psi or greater for epoxy polyurethane
Cyclic testing salt fog/UV, ASTM D5894:	1/4-inch or less undercutting at 3,000 hours.
QUV accelerated weathering test, ASTM D4587:	Passes 3,000-hour test with no blisters evident on either scribed or unscribed sides, or color difference, ASTM D2244.

Tabulation No. 3		
<p>Items to be coated:</p> <ol style="list-style-type: none"> <li>Exterior surfaces of exposed outdoor steel water storage tanks and associated appurtenances.</li> <li>Exterior surfaces of exposed indoor and outdoor ferrous piping, couplings, fittings and valves.</li> <li>Exterior surfaces of exposed air vent piping. Coat in safety yellow and gloss.</li> <li>Coat all fasteners.</li> </ol>		
Coating Material – Option 1 Zinc Rich Epoxy Primer/Epoxy/Polysiloxane	Number and Thickness of Coats	Surface Preparation Method
<p>Carboline: Carbozinc 859/ Carboguard 691/ Carboxane 2100</p> <p>International Paint: Interzinc 52/ Intergard 475HS/ Interfine 979</p> <p>PPG: Amercoat 68HS or Amercoat 68HS VOC/ Amerlock 2 or 400/ PSX 700</p> <p>Sherwin Williams: Zinc Clad III HS or 100/ Duraplate 235 or Macropoxy 646/ Polysiloxane XLE 80</p> <p>Color and gloss: See Color Schedule</p>	<p>1 or more prime coats apply at 3 to 5 mils DFT per coat, plus stripe coats.</p> <p>1 or more intermediate coats apply at 6 to 8 mils DFT per coat.</p> <p>1 or more finish coats apply at 3 to 7 mils DFT per coat.</p> <p>Total system excluding stripe coats: 12-mil DFT, minimum 20-mil DFT, maximum</p>	<p>Method A followed by:</p> <p>Uncoated surfaces: Method C</p> <p>Damaged coated surfaces: Method C-1 where abrasive blasting is impractical.</p> <p>Follow manufacturer's surface preparation and application instructions to apply subsequent coats.</p>
Coating Material – Option 2 Zinc Rich Epoxy Primer/Epoxy/Polyurethane	Number and Thickness of Coats	Surface Preparation Method
<p>Carboline: Carbozinc 859/ Carboguard 691/</p>	<p>1 or more prime coats apply at 3 to 5 mils DFT per coat, plus stripe coats.</p>	<p>Method A followed by:</p> <p>Uncoated surfaces: Method C</p>

Tabulation No. 3		
<p>Carbothane 134 HB, HG, or VOC International Paint: Interzinc 52/ Intergard 475HS/ Interthane 870 UHS</p> <p>PPG: Amercoat 68HS or 68 VOC/ Amerlock 2 or 400 Amercoat 450H or Amershield VOC</p> <p>Sherwin Williams: Zinc Clad III HS or 100/ Duraplate 235 or Macropoxy 646/ Hi solids polyurethane or 250</p> <p>Tnemec: Tneme-zinc 90-97/ Epoxoline Series N69 or V69/ Endura-shield 1075</p> <p>Color and gloss: See Color Schedule</p>	<p>1 or more intermediate coats apply at 6 to 8 mils DFT per coat.</p> <p>1 or more finish coats apply at 3 to 5 mils DFT per coat.</p> <p>Total system excluding stripe coats: 12-mil DFT, minimum 18-mil DFT, maximum</p>	<p>Damaged coated surfaces: Method C-1 where abrasive blasting is impractical.</p> <p>Follow manufacturer's surface preparation and application instructions to apply subsequent coats.</p>
<b>PERFORMANCE REQUIREMENTS:</b>		
<b>Testing Protocol</b>	<b>Acceptance Criteria</b>	
Abrasion resistance, ASTM D4060, CS-17 wheel, 1,000 cycles, 1-kg load:	Epoxy/polysiloxane: 80 milligram loss or less. Epoxy/polyurethane: 100 milligram loss or less.	
Direct impact, ASTM D2794:	Epoxy/polysiloxane: 40 inch-pounds. Epoxy/polyurethane: 30 inch-pounds.	
Pulloff adhesion, ASTM D4541, annex A2, type II tester:	Epoxy/polysiloxane: 1,000 psi or greater, Epoxy polyurethane	
Cyclic testing salt fog/UV, ASTM D5894:	1/4-inch or less undercutting at 3,000 hours	
QUV accelerated weathering test, ASTM D4587:	Passes 3,000-hour test with no blisters evident on either scribed or unscribed sides, or color difference ASTM D2244	

## Tabulation No. 4

Items to be coated: For potable water service, NSF 61 approved coating:

- a. Interior surfaces of steel water storage tanks.

For equipment in burial, immersion, and located in the plant or in vaults:

- a. Interior and exterior ferrous surfaces of pumps bowls. Pumps may be coated with fusion bonded epoxy at no additional cost to project.
- b. Interior and exterior ferrous surfaces of buried valves, exposed valves in pumping plant or exposed valves in vaults. Valves may be coated with fusion bonded epoxy at no additional cost to project.
- c. Interior and exterior ferrous surfaces of buried piping.
- d. Interior and exterior ferrous surfaces of pumping plant exposed piping and fittings.
- e. Interior and exterior ferrous surfaces of vault exposed piping and fittings.
- f. Interior of ferrous surfaces of piping and fittings embedded in concrete.
- g. Interior and exterior ferrous surfaces of air chamber piping.
- h. Flange supports.
- i. Interior and exterior of cast iron or ductile iron pipe and fittings. May be coated with fusion bonded epoxy.
- j. Interior and exterior of metal fittings for turnout PVC piping and may be coated with fusion bonded epoxy at no additional cost to project.
- k. Interior of ferrous surfaces of turnout building piping and associated appurtenances.
- l. Coat all fasteners.

## Notes:

3. Materials listed below require certified NSF 61 approval for contact with potable water.
4. Do not coat stainless-steel, bronze, or non-metallic surfaces.
5. Do not coat mating surfaces, machine surfaces, seals, and surfaces where coating could interfere with proper operation or fit.
6. Coat exposed machined surfaces after assembly.

Coating Materials – Option 1 Epoxy	Number and Thickness of Coats	Surface Preparation Method
Carboline: Carboguard 691  PPG (Ameron): Amerlock 2  Sherwin Williams: Duraplate 235 PW  Tnemec: Pota-Pox Series 20	3 or more base coats apply at 6 to 8 mils DFT per coat, plus stripe coats.  Total base coat system excluding stripe coats: 18-mil DFT, minimum 24-mil DFT, maximum	Method A followed by:  For cast-iron or ductile-iron: Method F or F-1  For steel: Method H  For damaged coated surfaces: Method C-1 where abrasive blasting is impractical.  2-4 mil surface profile.

Tabulation No. 4		
Color and gloss: Interior - manufacturer's standard color and gloss. Exterior – light grey or light tan.		Follow manufacturer's surface preparation and application instructions to apply subsequent coats.
Coating Materials – Option 2 High Solids Epoxy	Number and Thickness of Coats	Surface Preparation Method
<p>Sherwin Williams: Sherplate PW Epoxy</p> <p>Color and gloss: Interior – manufacturer's standard color and gloss. Exterior – light grey or light tan.</p>	<p>1 or more base coats apply at 30 to 40 mils DFT per coat, plus stripe coats.</p> <p>Total base coat system excluding stripe coats: 30-mil DFT, minimum 40-mil DFT, maximum</p>	<p>Method A followed by:</p> <p>For cast-iron or ductile-iron: Method F or F-1</p> <p>For steel: Method H</p> <p>For damaged coated surfaces: Method C-1 where abrasive blasting is impractical.</p> <p>2-4 mil surface profile.</p> <p>Follow manufacturer's surface preparation and application instructions to apply subsequent coats.</p>
Coating Materials – Option 3 100% Solids Epoxy	Number and Thickness of Coats	Surface Preparation Method
<p>International (Enviroline): Enviroline 230</p> <p>Raven Lining Systems: AquataPoxy A-6</p> <p>Color: Interior - manufacturer's standard color and gloss. Exterior – light grey or light tan.</p>	<p>1 or more base coats apply at 30 to 50 mils DFT per coat, plus stripe coats.</p> <p>Total coat system excluding stripe coats: 30-mil DFT, minimum 50-mil DFT, maximum</p>	<p>Method A followed by:</p> <p>For cast-iron or ductile-iron: Method F or F-1</p> <p>For steel: Method H</p> <p>For damaged coated surfaces: Method C-1 where abrasive blasting is impractical</p> <p>2-4 mil surface profile.</p> <p>Follow manufacturer's surface preparation and application instructions to apply subsequent coats.</p>

Tabulation No. 4		
Coating Materials – Option 4 100% Solids Epoxy	Number and Thickness of Coats	Surface Preparation Method
<p>Carboline: Plasite 4500 S</p> <p>NSP Products: NSP 120</p> <p>Sherwin Williams: Dura-Plate UHS</p> <p>Color and gloss: Interior - manufacturer's standard color and gloss. Exterior – light grey or light tan.</p>	<p>2 or more base coats apply at 10 to 16 mils DFT per coat.</p> <p>Total coating system excluding stripe coats: 20-mil DFT, minimum 32-mil DFT, maximum</p>	<p>Method A followed by:</p> <p>For cast-iron or ductile-iron: Method F or F-1</p> <p>For steel: Method H</p> <p>For damaged coated surfaces: Method C-1 where abrasive blasting is impractical.</p> <p>2-4 mil surface profile.</p> <p>Follow manufacturer's surface preparation and application instructions to apply subsequent coats.</p>
<b>PERFORMANCE REQUIREMENTS:</b>		
<b>Testing Protocol</b>		<b>Acceptance Criteria</b>
Fresh/deionized water immersion test, ASTM D870:		Passes, 2-years test with aerated water held at ambient temperature with no blisters evident on either scribed or unscribed sides.
Dilute Harrison immersion test, Modified ASTM D870:		Passes, 2-years test with aerated water held at ambient temperature with no blisters evident on either scribed or unscribed sides.
Abrasion resistance, ASTM D4060, CS-17 wheel, 1,000 cycles, 1-kg load:		Epoxy: 100 milligram loss or less.
Direct impact, ASTM D2794:		30 inch-pounds.
Pulloff adhesion, ASTM D4541, annex A2, Type II tester:		1,000 psi or greater.
Cyclic testing salt fog/UV, ASTM D5894:		1/4-inch or less undercutting at 3,000-hours.
Cathodic disbondment, ASTM G8:		No disbondment at 120-day test.

Tabulation No. 5

Items to be coated: Steel and Concrete:

- a. Interior and exterior ferrous surfaces of the outdoor steel water storage tank.
- b. Interior and exterior ferrous surfaces of the outdoor water piping, fitting, and valves for both the concrete and steel tanks.
- c. Exterior surfaces of concrete tanks.
- d. Interior and exterior ferrous surfaces of the overflow piping and flap valve for both the concrete and steel tanks.
- e. Exterior surfaces of the steel wall manhole and hatch covers for the concrete and steel tanks.
- f. Tank dome vent.
- g. Surfaces of accompanying metalwork to be coated and not left galvanized: Ladders, stairs, walkways, hatches, balconies, safety cages, handrail, safety railings, platforms, and catwalks.
- h. All fasteners.

Notes:

1. Materials listed below require certified NSF 61 approval for contact with potable water.
2. Do not coat stainless-steel, bronze, or non-metallic surfaces.
3. Do not coat mating surfaces, machine surfaces, seals, and surfaces where the coating could interfere with proper operation or fit.
4. Coat exposed machined surfaces after assembly.

Option No. 1 - Welded Steel Tanks:

- a. Coat atmospheric service exterior ferrous surfaces in accordance with Tabulation No. 3.
- b. Coat immersion service and burial interior and exterior ferrous surface in accordance with Tabulation No. 4.

Option No. 2 – Bolted Steel Tanks:

- a. Interior and exterior of bolted steel water storage tank option including all associated piping and equipment.
- b. Coatings are to meet the requirements of AWWA D103.
- c. Coat all immersion service ferrous piping and equipment not covered under AWWA D103 using Tabulation No. 4.
- d. Do not use liquid coatings for bolted tank lining.

Option No. 03 – Concrete Tanks:

- a. Exterior surfaces of concrete tanks.

Exterior Coating Materials Waterproof Coating	Number and Thickness of Coats	Surface Preparation Method
Cement based, heavy duty waterproof coating. Fills and seals concrete pores and voids	Apply at manufacturer's recommended thickness per coat.	Method T

Tabulation No. 5		
<p>while resisting hydrostatic pressure:</p> <p>Waterproof coating:</p> <p>BASF Thoroseal or equivalent</p>		
<p>Finish coats:</p> <p>Water Borne Light Industrial Coatings for specified exterior service exposure and gloss, use:</p> <p>Exterior No. 161, eggshell-like Exterior No. 163, semigloss Exterior No. 164, gloss</p> <p>Color and gloss: See Color Schedule</p>	<p>2 or more compatible manufacturer's finish coats.</p> <p>Follow manufacturer's instructions for thickness per coat.</p> <p>Total system: 6 to 10-mil DFT</p>	<p>Follow manufacturer's surface preparation and application instructions to apply subsequent coats.</p>
Approved Materials: Materials from MPI APL		

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Tabulation No. 6
<p>Repair of Damaged Galvanizing:</p> <ol style="list-style-type: none"> <li>a. Exposed evaporative cooler ductwork.</li> <li>b. Hatch covers.</li> <li>c. Gratings.</li> <li>d. Ladders.</li> <li>e. Handrails and safety railings.</li> <li>f. Platforms.</li> <li>g. Chain link fencing.</li> <li>h. Damaged galvanized surfaces not otherwise tabulated.</li> </ol>
<p>Repair damaged galvanized surfaces in accordance with ASTM A780. Repair materials containing cadmium and lead are not permitted.</p>

Tab AE-11.DOCX

Tabulation No. 7		
Items not to be coated and to receive a uniform passivation layer:		
a. Stainless-steel-clad surfaces not otherwise tabulated herein		
Note:		
1. Do not coat stainless-steel items listed above. Stainless-steel surfaces to receive uniform passivation. Clean and restore uniform passivation layer on damaged, contaminated, or depassivated stainless-steel surfaces by methods listed below.		
Degree of Surface Contamination	ASTM A380* Surface Preparation Method**	ASTM A380* Surface Preparation Test**
Local heavily contaminated surface areas:  Contaminated by free iron, oxide scale, or rust related contaminants caused by field welding or cutting.	Method 5. - "Descaling," General:  Method 5.3 - "Mechanical Descaling" by grinding,  and/or  Method 6.3 - "Cleaning of Welds and Weld-Joint Areas."	Method 7.2 - "Gross Inspection."  Methods 7.2.5 - "Tests for Free Iron: Gross Indications."
General contaminated surface areas:  Contaminated by free iron, oxide scale, or rust related contaminants	Method 5. - "Descaling," General:  Method 5.2 - "Chemical Descaling"  Method 5.2.2.(1) - "Chemical Descaling" by swab or spray wetting the surfaces  and/or  Method 5.3 - "Mechanical Descaling" by grinding	Method 7.2 – "Gross Inspection"  Method 7.2.5 – "Tests for Free Iron: Gross Indication"

Tabulation No. 7		
General contaminated surface areas:  Contaminated by grease, oil, residual chemical films, or other non-free iron related contaminates	Method 6.2.10 - "Water Jetting"  and/or  Method 6.4 - "Final Cleaning, or Passivation, or Both," wiping with a clean, solvent-moistened cloth	Method 7.2 - "Gross Inspection"  Method 7.2.2 - "Wipe Tests"  Where films are not detectable under white light conditions, use:  Method 7.3 - "Precision Inspection"  Method 7.3.2 - "Black Light Inspection"
<p>* Other ASTM A380 methods may be used instead of above specified surface preparation methods and inspection procedures.</p> <p>** Do not damage attached parts, adjacent parts, or materials by field cleaning and passivation methods of stainless-steel.</p>		

Tab AE-14.DOCX

Tabulation No. 8		
Items to be coated:		
<ul style="list-style-type: none"> <li>a. Damp proofing and moisture barrier of the exterior of below grade concrete manholes and vaults.</li> <li>b. Coating aluminum in contact with concrete surfaces</li> </ul>		
Coating Materials	Number and Thickness of Coats	Surface Preparation Method
Exterior Bituminous coating, No. 25  Color and gloss: Black	2 or more heavy coats.  Follow manufacturer's instructions for dry or wet film thickness per coat.	Method T
Approved Materials: Materials from Master Painters Institute – Approved Products List ( <a href="http://www.paintinfo.com">www.paintinfo.com</a> )		

Tabulation No. 9		
Items to be coated: a. Exterior surfaces of above grade concrete masonry unit walls (CMU's), wall caps, and screen walls for pumping plant, chemical and turnout buildings.		
Coating Materials	Number and Thickness of Coats	Surface Preparation Method
Water Repellent Coating, not paintable, No. 117  Color and gloss: Clear	Follow manufacturer's instructions for number of coats and thickness per coat.	Method T
Approved Materials: Materials from Master Painters Institute – Approved Products List ( <a href="http://www.paintinfo.com">www.paintinfo.com</a> )		

Tab NM-04.DOCX

Tabulation No. 10		
Items to be coated: a. Exposed surfaces of chemical build floor and containment floor <i>and walls</i> .		
Coating Materials	Number and Thickness of Coats	Surface Preparation Method
High Build, Low Gloss Epoxy Flooring, No. 108  Color and gloss: See Color Schedule	Follow manufacturer's instructions for number of coats and thickness per coat.	Method T
Approved Materials: Materials from Master Painters Institute – Approved Products List ( <a href="http://www.paintinfo.com">www.paintinfo.com</a> )		

Tab NM-04.DOCX

Tabulation No. 11		
Items to be coated: a. Gypsum board.		
Coating Materials Latex	Number and Thickness of Coats	Surface Preparation Method
Primer/sealer for gypsum board substrate, use:  No. 50, Interior Latex Primer Sealer	Follow manufacturer's instructions for number of coats and thickness per coat.	Method U
Finish coats:  Interior High-Performance Latex for specified gloss, use:  No. 138, velvet No. 139, eggshell No. 140, satin No. 141, semigloss  Color and gloss: See Color Schedule	2 or more compatible manufacturer's finish coats.  Follow manufacturer's instructions for thickness per coat.	Follow manufacturer's surface preparation and application instructions to apply subsequent coats.
Approved Materials: Materials from Master Painters Institute – Approved Products List ( <a href="http://www.paintinfo.com">www.paintinfo.com</a> )		

Tabulation No. 12		
Items to be coated: a. Exposed surfaces of building foundation ridged insulation and stucco.		
Coating Materials	Number and Thickness of Coats	Surface Preparation Method
Latex, Exterior, High Build, No. 40  Color and gloss: See Color Schedule	Follow manufacturer's instructions for number of coats and thickness per coat.  Minimum total thickness is 10 mils, DFT.	Method T
Approved Materials: Materials from Master Painters Institute – Approved Products List ( <a href="http://www.paintinfo.com">www.paintinfo.com</a> )		

Tabulation No. 13		
Items to be coated or repaired:		
<ul style="list-style-type: none"> <li>a. Steel pipe.</li> <li>b. Cast iron or ductile iron pipe and fittings.</li> <li>c. Steel or cast-iron valves.</li> </ul>		
Notes:		
<p>1. For Bell and Spigot: Coating shall not extend beyond “stab line” of spigot. “Stab line” shall match outside face of bell when fully seated. Preserve existing bituminous coating beyond “stab line” of the spigot and protect from any damage during surface preparation and coating operations. Coat exterior of bell, up to and including front face of bell. Interior of bell shall not be blasted or coated. Coating shall be applied such that full depth of spigot end of pipe shall be achieved and provide nearly watertight seal at joint.</p>		
Coating materials – Option 1	Number and Thickness of Coats	Surface Preparation Method
Select Polyurethane coating for burial in accordance with the AWWA C222 Polyurethane Standard.	<p>1 or more base coats.</p> <p>Apply at 30 to 40 mils DFT per coat, plus stripe coats.</p> <p>Total system excluding stripe coats: 30-mil DFT, minimum 40-mil DFT, maximum</p>	<p>Method A followed by:</p> <p>For cast-iron or ductile iron: NAPF 500-03-05 Blast Clean No. 4</p> <p>For steel: Method H</p> <p>Achieve 3 to 5-mil surface profile, minimum</p> <p>Follow manufacturer’s surface preparation and application instructions to apply subsequent coats</p>
<b>PERFORMANCE REQUIREMENTS:</b>		
Testing Protocol	Acceptance Criteria	
Flexibility, ASTM D522, 180-degree bend over 3-inch mandrel:	passes, no cracking or delamination	
Impact resistance, ASTM G14:	75 in lbs, minimum	
Abrasion resistance, ASTM D4060, CS-17 wheel, 1,000 cycles, 1-kg load:	100 milligram loss or less	
Water Absorption, ASTM D570:	2.0 percent maximum	

Tabulation No. 13	
Hardness, ASTM D2240 Shore D:	65 minimum
Pulloff adhesion, ASTM D4541:	1,500 psi or greater
Cathodic disbondment, ASTM E95:	1/2-inch maximum 28-day test

Tab BE-01.DOCX

### 3.11 COLOR SCHEDULE

- A. Colors and glosses of finished coats:
1. To be selected and approved by COR.
- B. Color and gloss to meet one or more of following:
1. Munsell Color.
  2. SAE AMS-STD-595.
  3. Manufacturer's standard color.
- C. Gloss abbreviations:
- a. G - Full Gloss.
  - b. SG - Semigloss.
  - c. F - Flat.
- D. Color schedule table:
1. Numbers listed in the "Tabulation No." column correspond to "Items to be coated" listed in Coating Tabulations.

Table 09 96 20A – Color Schedule

Tabulation No.	Item Surface	Color	Color No.	Gloss
1	Manufacturer's Standard Color and Gloss			
2		To be selected by COR		SG

Table 09 96 20A – Color Schedule

Tabulation No.	Item Surface	Color	Color No.	Gloss
3	a. Exterior surfaces of outdoor steel water storage tanks and associated appurtenances. b. Exterior surfaces of exposed outdoor ferrous piping, couplings, fittings and valves.	Beige	Munsell 2.5Y8/4	SG or G
4	a. Interior – Manufacturer’s standard light color and gloss. b. Exterior – Manufacturer’s standard light grey or tan and gloss.	To be selected by COR		
5	a. Exterior surfaces of outdoor steel, concrete, or bolted water storage tanks and associated appurtenances.	Beige	Munsell 2.5Y8/4	SG or G
10	a. Exposed surfaces of chemical build floor and containment floor.	Light Grey		
11	a. Gypsum board	Off-White	SAE AMS-STD-595	SG
12	a. Exposed surfaces of building foundation ridged insulation and stucco.	To be selected by COR		

**END OF SECTION**

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**SECTION 10 14 00**  
**SIGNAGE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Signage:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. National Fire Protection Association (NFPA)

- |    |                 |   |
|----|-----------------|---|
| 1. | NFPA 704 (2017) | Standard System for the Identification of the Hazards of Materials for Emergency Response |
|----|-----------------|---|

B. International Code Council (ICC)

- |    |                           |  |
|----|---------------------------|--|
| 1. | IFC (2018)                | International Fire Code                        |
| 2. | IBC (2018)                | International Building Code                    |
| 3. | ICC/ANSI A117.1-09 (2017) | Accessible and Usable Buildings and Facilities |

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 10 14 00-1, Shop Drawings and Approval Data:

1. Manufacturer's specifications and technical data indicating compliance with this section.
2. Submit list of required signs. Refer to drawings 1695-D-60375 and -60383.
3. Complete set of manufacturer's standard color and product samples for selection of signs, lettering, character and background colors, material and style. Color copies of these items are not acceptable and will be returned not approved.
4. Submit shop drawings for each type of sign showing dimensions of plaque and characters, and text, symbols, and braille to be included on each sign. Shop drawings should also include proposed locations for each sign on a floor plan and typical horizontal and vertical locations of signage.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. “No Smoking” signs in accordance with IFC Sections 5003.7.
- B. Hazard Identification Signs in accordance with IFC Sections 5003.5 and 5003.6 and NFPA 704.

### **2.02 EXTERIOR ALUMINUM SIGNS**

- A. Coated aluminum exterior signs manufactured by Signs.com, 1550 South Gladiola Street, Salt Lake City UT, 84104; [www.signs.com](http://www.signs.com), or equal, having the following essential characteristics:
  - 1. One-sixteenth-inch-thick coated aluminum material; corrosion-resistant, abrasion-resistant, rust-resistant, heavy-duty, rigid, weather-resistant.
  - 2. Reflective.
  - 3. Pre-drilled holes.
  - 4. Rounded corners.
  - 5. Characters: Upper case, sans serif.
  - 6. Color: To be determined by Government from manufacturer’s standard color chart.
  - 7. Braille: No.
  - 8. Mounting: On exterior walls or other features as required, as recommended by manufacturer for surface conditions.

### **2.03 INTERIOR SIGNS**

- A. Coated aluminum interior signs manufactured by Signs.com, 1550 South Gladiola Street, Salt Lake City UT, 84104; [www.signs.com](http://www.signs.com), or equal, having the following essential characteristics:
  - 1. One-sixteenth-inch-thick coated aluminum material; corrosion-resistant, abrasion-resistant, rust-resistant, heavy-duty, rigid.
  - 2. Non-reflective.
  - 3. Pre-drilled holes.
  - 4. Rounded corners.
  - 5. Characters: Upper case, sans serif.
  - 6. Color: To be determined by Government from manufacturer’s standard color chart.
  - 7. Braille: No.
  - 8. Mounting: On interior walls or other features as required, as recommended by manufacturer for surface conditions.

- B. Acrylic interior signs manufactured by Office Sign Company, LLC, 310 NP Avenue N., Fargo ND 58102; [www.officesigncompany.com](http://www.officesigncompany.com) or equal, having the following essential characteristics:
1. In accordance with IBC Section 1013.4.
  2. One-eighth-inch-thick acrylic material.
  3. Self-extinguishing.
  4. Rounded corners.
  5. Characters: Upper case, raised (1/32- inch minimum depth), sans serif.
  6. Color: Non-glare, white characters on black background.
  7. Braille: Yes.
  8. Mounting: On interior walls, as recommended by manufacturer for surface conditions.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. In accordance with manufacturer's instructions.
- B. Locations: In accordance with drawings 1695-D-60375, -60383, and reference standards. Height: Unless noted otherwise, signage shall be 48-inch minimum and 60-inch maximum above the adjacent floor, measured from the baseline of the characters.
- C. Distance from door: Signs shall have a minimum 18- by 18-inches space on wall, centered on the sign, beyond the arc of door swing between closed position and 45-degree open position.
- D. Protect exposed surfaces until final acceptance of the work in a manner sufficient to prevent damage or discoloration. Work damaged or discolored prior to final acceptance shall be replaced without additional cost to Government.
- E. Final cleaning of surfaces shall be carefully done in accordance with the manufacturer's instructions.

**END OF SECTION**

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**SECTION 10 14 01**  
**ENTRY SIGN**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Entry Sign:
1. Payment: Lump sum price offered in the Price Schedules.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 10 14 01-1, Manufacturers Information:
1. Shop drawings: Show sign layout, text, graphics, materials, colors, dimensions, and anchoring and foundation details. Include site plan showing location of sign(s).
  2. Product data.
  3. Storage, handling, and installation instructions.

**PART 2 PRODUCTS**

**2.01 ENTRY SIGN AND POSTS**

- A. In accordance with NTUA Sign Guidelines.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install in accordance with NTUA Sign Guidelines.

**END OF SECTION**

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**SECTION 10 14 26**  
**UTILITY MARKERS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 REFERENCE STANDARDS**

A. New Mexico State Law

1. NMOC Color Codes New Mexico One Call (NMOC)

**PART 2 PRODUCTS**

**2.01 UTILITY MARKERS**

A. CRM3066, Utility Marker, manufactured by Carsonite, [www.carsonite.com](http://www.carsonite.com), or equal with the following essential characteristics:

1. Durable.
2. UV resistant.
3. T-cross section with support ribs along each edge.
4. Resistant to impact, ozone and hydrocarbons.
5. Service temperature range: -40 degrees F to 140 degrees F.
6. Width: 3.75-inches.
7. Length: 60-inches minimum.
8. Anchor Barb.
9. Color: Blue in conformance NMOC Color Codes.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Use manual driving tool drive per manufacturer's recommendations.
- B. Install approximately 50 at locations directed by COR.

**END OF SECTION**

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**SECTION 10 44 20**  
**FIRE EXTINGUISHERS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Fire Extinguishers:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. National Electrical Manufacturers Association (NEMA)

1. NEMA Z535.2-2011 Environmental and Facility Safety Signs

B. National Fire Protection Association (NFPA)

1. NFPA 10-~~2013~~[2018](#) Portable Fire Extinguishers

C. National Fire Protection Association (NFPA)

1. UL 299-2012 Dry Chemical Fire Extinguishers
2. UL 711-~~2004~~[2018](#) Rating and Fire Testing of Fire Extinguishers

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 10 44 20-1, Approval Data:

1. Manufacturer's technical data, certification of UL rating, and installation instructions for all portable fire extinguishers.

**PART 2 PRODUCTS**

**2.01 FIRE EXTINGUISHERS**

A. Hand-Held Portable Dry Chemical Fire Extinguishers:

1. UL 299 Dry Chemical Fire Extinguisher.
2. Twenty-pound agent capacity.
3. Minimum UL 711 - UL rating 10A:120B:C, multi-purpose pressurized dry chemical, manufacturer's rated temperature range above -27 degrees F and below 120 degrees F.

4. Red glossy coated steel shell.
  5. Minimum 12-year hydrostatic test requirement.
  6. Waterproof pressure gauge, wall mounted, hand-operated, minimum 15-foot stream.
  7. Provide all bolts, screws, expansion anchors, and mounting brackets required for installation of hand-held portable fire extinguishers. Mounting hardware and fasteners shall be corrosion resistant stainless steel.
- B. Recessed Cabinet for Dry Chemical Extinguisher:
1. Embassy Fire-FX 5734 V17 by J.L. Johnson Industries, Incorporated, or equal, with the following characteristics:
    - a. Maximum depth 8-inches.
    - b. 2-hour fire-rated extinguisher cabinets.
    - c. Stainless steel tub and doors.
    - d. Safety glass vision panel.
    - e. Concealed hinges and handles with manufacturer's standard door roller catches.
    - f. Vertical fire extinguisher decal.
    - g. Coordinate size of recessed fire extinguisher cabinets required with extinguisher selected for complete system integration.
- C. Outdoor Cabinet for Dry Chemical Extinguishers:
1. FB Series Fiberglass Fire Extinguisher Cabinet by J.L. Johnson Industries, Incorporated, or equal, with the following characteristics:
    - a. Fiberglass tub and door construction.
    - b. UV resistant.
    - c. Full length stainless steel hinge.
    - d. Rubber-gasketed door.
    - e. Red finish.
    - f. Safety glass or acrylic view window.
    - g. Coordinate size of outdoor fire extinguisher cabinets required with extinguisher selected for complete system integration.
- D. Labeling:
1. Provide signs to indicate location of extinguishers.
  2. NEMA Z535.2

## 2.02 COATINGS

- A. Manufacturer's standard finish for fire extinguishers in accordance with Section 09 96 20 – Coatings.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. In accordance with NFPA 10, install hand-held portable extinguishers and recessed fire extinguisher cabinets as follows:
1. Pumping plant and air chamber:
    - a. Four hand-held portable dry chemical extinguishers on the interior walls:
      - 1) Adjacent to each of the following egress doors: 101, 103, 104 and 106.
    - b. One hand-held portable dry chemical extinguishers in a cabinet on the interior wall:
      - 1) Near building line 10 and between building lines C and B; inside Air Chamber Room 102, along the exterior east wall of the Control Room
    - c. Three hand-held portable dry chemical extinguisher in cabinet on exterior walls:
      - 1) Adjacent to each of the following egress doors: 101, 103, and 106.
  2. Chemical building:
    - a. Two hand-held portable dry chemical extinguishers in a cabinet on interior walls:
      - 1) Adjacent to each of the following egress doors: 001 and 002.
      - 2) Adjacent to the exit of "clear opening".
    - b. One hand-held portable dry chemical extinguishers in a cabinet on exterior walls:
      - 1) Adjacent to building line 3 on building line A
  3. Turnout Building:
    - a. Two hand-held portable dry chemical extinguisher on the interior walls one adjacent to each set of double doors.
- B. Install signs directly above surface mounted portable fire extinguishers, securely mounted, attached to substrate in accordance with manufacturer's instructions. Install level and plumb.

**END OF SECTION**

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**SECTION 10 51 00**  
**LOCKERS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Lockers:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 10 51 00-1, Approval Data and Color Sample Kit:

1. Manufacturer's product data for lockers.

**PART 2 PRODUCTS**

**2.01 LOCKERS**

A. Plastic Box Locker, manufactured by Lenox, [www.schoollockers.com](http://www.schoollockers.com), or equal with the following essential characteristics:

1. Locker width: 15-inches.
2. Locker depth: 15-inches.
3. Locker height: Total unit height 72-inches.
4. Body thickness: 3/8-inch.
5. Dent, scratch, and corrosion resistant.
6. Construction material: HDPE.
7. Latch: Continuous slide type, lockable.
8. Continuous, *full length* hinge: Stainless steel *or aluminum*.
9. Shelf and hook.
10. Finished end panels.
11. Drain hole.
12. Sloped top.

**2.02 ACCESSORIES**

A. Wall anchor attachment points as recommended by manufacturer.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Assemble in accordance with manufacturer's instructions.
- B. Install where shown on drawings.

**END OF SECTION**



- C. American Institute of Steel Construction (AISC)
1. AISC 303-10 Code of Standard Practice for Structural Steel Buildings and Bridges
  2. AISC 325-11 Steel Construction Manual, 14th Edition
  3. AISC 348-09 Structural Joints Using High-Strength Bolts
  4. AISC 360-10 Structural Steel Buildings
  5. AISC DG3-2003 Steel Design Guide Series 3 – Serviceability Design Considerations for Steel Buildings
  6. AISC RCSC-04 RCSC (Research Council of Structural Connections) Specifications for Structural Joints Using ASTM A325 or A490 Bolts (available at [www.boltcouncil.org](http://www.boltcouncil.org))
- D. American Iron and Steel Institute (AISI)
1. AISI S100-2007 North American Specification for the Design of Cold-Formed Steel Structural Members
- E. American Society of Civil Engineers (ASCE)
1. ASCE 7-10 Minimum Design Loads for Buildings and Other Structures
- F. American Welding Society (AWS)
1. AWS A2.4-12 Standard Symbols for Welding, Brazing, Nondestructive Examination
  2. AWS D1.1/D1.1M-15 Structural Welding Code - Steel
  3. AWS D1.3/D1.3M-08 Structural Welding Code - Sheet Steel
- G. International Accreditation Services (IAS)
1. IAS AC472 Accreditation Criteria for Inspection Programs for Manufacturers of Metal Buildings
- H. International Code Council (ICC)
1. IBC-2015 International Building Code
  2. IFC-2015 International Fire Code
- I. Metal Building Manufacturers Association (MBMA)
1. MBMA Manual Metal Building Systems Manual, 2012 Edition
  2. MBMA Manual Supplement 2010 Supplement to the 2006 Metal Building Systems Manual

- J. National Fire Protection Association (NFPA)
  - 1. NFPA 101-2015 Life Safety Code
- K. Underwriters Laboratories Inc. (UL)
  - 1. UL 580-06 Tests for Uplift Resistance of Roof Assemblies

### **1.03 SYSTEM DESCRIPTION**

- A. Building System:
  - 1. Pumping Plant
    - a. Type: Pre-engineered, clear span rigid frame.
    - b. Size: As shown on drawings.
    - c. Roof Slope: As shown on drawings.
    - d. Bay Spacing: As shown on drawings.
    - e. Primary Framing: Rigid frame of rafter beams and columns and endwall columns.
    - f. Secondary Framing: Purlins, girts, eave struts, flange bracing, jambs, headers, sill supports, clips, and other miscellaneous structural parts.
    - g. Lateral Bracing: Horizontal loads not resisted by primary framing shall be resisted by cables, rods, and/or portal frames in the sidewall. Cables, rods and/or portal frames in the end walls. Cable, rod and/or diaphragms in the roof.
    - h. Exterior Walls and Roof: Preinsulated metal panel cladding system with insulating foam core and doors. Includes flashing, trim and other accessories to make complete system as indicated on drawings.
    - i. Control Room Interior Walls and Ceiling: Preinsulated metal panel cladding system with insulating foam core on steel joist and stud wall framing system. Includes flashing, trim and other accessories to make complete system as indicated on drawings.
    - j. Building framing design shall account for all mechanical, electrical and plumbing equipment wall and roof penetrations as indicated on drawings or as otherwise required. Additional structural support shall be provided as required.
    - k. Accessories: Louvers, gutters, downspouts, splash blocks, roll-up doors (2), paired door and hardware (1), door and hardware (4), window (2), skylights, aluminum wall ladder, and roof fall protection and rail system.
    - l. Design, fabricate, furnish and erect metal building complete with wall accessories, roof hatches, removable roof covers, aluminum wall ladder, roof fall protection rail system, and control room.

2. Chemical Building
  - a. Type: Pre-engineered, clear span rigid frame.
  - b. Size: As shown on drawings.
  - c. Roof Slope: As shown on drawings.
  - d. Bay Spacing: As shown on drawings.
  - e. Primary Framing: Rigid frame of rafter beams and columns and endwall columns.
  - f. Secondary Framing: Purlins, girts, eave struts, flange bracing, jambs, headers, sill supports, clips, and other miscellaneous structural parts.
  - g. Lateral Bracing: Horizontal loads not resisted by primary framing shall be resisted by cables, rods, and/or portal frames in the sidewall. Cables, rods and/or portal frames in the end walls. Cable, rod and/or diaphragms in the roof.
  - h. Exterior Walls and Roof: Preinsulated metal panel cladding system with insulating foam core and doors. Includes flashing, trim and other accessories to make complete system as indicated on drawings.
  - i. Building framing design shall account for all mechanical, electrical and plumbing equipment wall and roof penetrations as indicated on drawings or as otherwise required. Additional structural support shall be provided as required.
  - j. Accessories: Louvers, gutters, downspouts, splash blocks, paired door and hardware (1), and door and hardware (1).
  - k. Design, fabricate, furnish and erect metal building complete with wall accessories and removable roof cover.
3. Turnout Building:
  - a. Walls and Roof: Preinsulated metal panel cladding system with insulating foam core and doors. Includes flashing, trim and other accessories to make complete system as indicated on drawings.  
 Accessories: Louvers, gutters, downspouts, splash blocks, paired door and hardware (2), and door and hardware (1).

#### **1.04 REFERENCE SPECIFICATION SECTIONS**

- A. 05 40 00 – Cold-Formed Metal Framing
- B. 05 51 30 – Aluminum Wall Ladder and Platform
- C. 05 52 20 – Fall Protection Rail System
- D. 07 21 13 – Sound Control Batt Insulation

- E. 07 21 20 – Extruded Polystyrene Foam Insulation
- F. 07 21 50 – Spray-Applied Polyurethane Foam Insulation
- G. 07 41 13 – Preinsulated Metal Roof Panels
- H. 07 42 13 – Preinsulated Metal Wall Panels
- I. 07 72 30 – Roof Hatches
- J. 07 92 00 – Joint Sealants and Masonry Joints
- K. 08 11 10 – Steel Doors and Frames
- L. 08 33 20 – Roll-Up Doors
- M. 08 51 20 – Steel Windows
- N. 08 62 00 – Unit Skylights
- O. 08 71 00 – Door Hardware
- P. 09 29 00 – Gypsum Board
- Q. 09 65 10 – Rubber Wall Base
- R. 09 96 20 – Coatings
- S. 23 37 00 – Air Inlets and Outlets

#### **1.05 DESIGN REQUIREMENTS**

- A. Design in accordance with MBMA Manual, IBC, IFC, and NFPA 101. In case of conflicts between the manual and design codes, the most stringent requirement governs.
- B. Structural Performance: Provide building system capable of withstanding the effects of the following loads:
  - 1. Dead Loads: Dead loads shall be the weight of Metal Building System and as determined by system manufacturer.
  - 2. Live Loads: As shown on drawings.
  - 3. Wind Loads: As shown on drawings.
  - 4. Snow Loads: As shown on drawings.
  - 5. Seismic Loads: As shown on drawings.
  - 6. Collateral Loads: Support collateral loads imposed by doors, cable trays, etc. and other equipment and accessories supported by building structure. Collateral loads shall not be applied to roof panels.

7. Rainfall Intensity: All exterior gutters and downspouts shall be designed for rainfall intensity based upon a 5-year recurrence interval for five-minute duration in accordance with MBMA Manual.
  8. Other design loads: As shown on drawings.
  9. Deflection requirements shall be in accordance with applicable provisions of AISC Steel Design Guide Series 3 – Serviceability Design Considerations for Steel Buildings.
  10. Removable Roof Covers:
    - a. Shall be designed and constructed so-as-to permit installation and removal of each roof cover (structural steel framing, preinsulated metal wall panels, hoist points, connections, fasteners, trims, sealants, etc.) during and after construction.
    - b. Shall be positively attached to supporting structural steel frame using a method that is accessible without causing damage to surrounding structural and architectural components and permits roof cover to be disconnected from inside the building.
    - c. Shall be insulated from supporting structural steel so-as-to minimize noise from vibration.
- C. Thermal Effects:
1. Roof panels shall be free to move in response to expansion and contraction forces resulting from temperature variation.
  2. Roof assembly to permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subjected to temperature range of 100 degrees F.
- D. Provide rough framing for all skylights, roof ventilators, louvers, doors, and openings as shown on drawings or as otherwise required.
- E. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflections of building superstructure.
- F. Design of anchorage, including embedment and supplemental anchorage reinforcement details shall be based upon manufacturer's column reactions and column base plate details and performed in accordance with ACI 318. Manufacturer responsible for providing column location, diameter, and material strength of anchor bolt assemblies.
- G. Coordinate with specification sections listed under 1.04 – Reference Specification Sections.

## **1.06 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 13 34 21-1, Approval Drawings and Data:

1. Manufacturer's shop drawings (Government Format):
  - a. Government will provide an electronic AutoCAD drawing to be used for the submittal process.
  - b. Show building layout and dimensions; sections through building; wall and roof framing plans; roof and wall openings; gutters and downspouts; erection details; ridge, eave, rake, corner, sill, opening, and trim details; roof and wall penetration details; and type, grade, size, and thickness of materials.
  - c. Show special seismic requirements, if required, on connection details.
  - d. Include an anchor bolt assemblies plan, which shows type, material, location, diameter, and projection of anchor bolts.
  - e. Project-specific drawings except as permitted for details. Manufacturer's standard or typical drawings may be included to show details. Mark standard or typical drawings to indicate details relevant to project.
  - f. Signed and sealed by engineer registered in State of New Mexico.
2. Manufacturer's product data:
  - a. Include complete descriptions of and specifications for building system and materials.
  - b. Product test reports.
3. Manufacturer's design data:
  - a. Design data which shows magnitude and direction of column reactions at base of each column. Provide anchor assembly column location, diameter, and material strength. Do not proceed with foundation reinforcement until receipt of revised drawings.
  - b. Signed and sealed by engineer registered in State of New Mexico.

C. RSN 13 34 21-2, Certification:

1. Letters of design certification for metal building system:
  - a. Include manufacturer's order numbers.
  - b. Affidavit certifying sheet steel complies with specified quality, and grade.
  - c. List design criteria including codes, standards, and loads.
  - d. Certify structural design complies with specified design requirements.
  - e. Signed and sealed by design engineer registered in State of New Mexico.

D. RSN 13 34 21-3, Design Data:

1. Calculations indicating that structural design complies with specified design requirements.

2. Design data, which shows magnitude and direction of column reactions at base of each column. Do not proceed with foundation reinforcement until receipt of revised drawings.
  3. Signed and sealed by engineer registered in State of New Mexico.
- E. RSN 13 34 21-4; Anchorage Design Data:
1. Anchorage calculations indicating that structural design complies with specified design requirements.
  2. Design data, which shows anchorage details including embedment and supplemental anchorage reinforcement as needed.
  3. Signed and sealed by registered professional engineer registered in the State of New Mexico.
- F. RSN 13 34 21-5, Erection Plans, Manual, and Documentation:
1. Final drawings in “Government Format”.
  2. Manufacturer’s erection plans and closeout maintenance manual for building system:
    - a. Include manufacturer’s instructions for field touch-up of finishes.
  3. Written evidence that building erector is authorized as specified.
- G. RSN 13 34 21-6, Fabricator Qualifications
1. As identified below.

## **1.07 QUALIFICATIONS**

- A. Designer Qualifications: Professional engineer registered in State of New Mexico.
- B. Fabricator: Qualified fabricator in accordance with IAS AC472
- C. Erector Qualifications: Authorized by building system manufacturer to erect building system. Proof of completion of 3 projects of similar scope with current verifiable references.
- D. Welding:
  1. Welding and related work in accordance with AWS D1.1 and AWS D1.3.
  2. Welding symbols on fabricator’s shop drawings in accordance with AWS A2.4, unless otherwise noted.
- E. Bolting: In accordance with AISC 325, AISC 360, AISC 348, and AISI S100.

## **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver metal framing to the site in manufacturers’ unopened containers or bundles, identified with brand, type, and gauge.

- B. Protect from damage and rusting. Store off ground in dry, ventilated space. If necessary, to store materials outside, stack off the ground, support on level platform, and protect from weather as approved.
- C. Store with sufficient clearance around materials to permit easy access for inspection and handling.
- D. Store and handle in manner that will not cause distortion.

### **1.09 WARRANTY**

- A. Building manufacturer shall provide manufacturer's standard material warranty.
- B. Metal building contractor shall provide a workmanship warranty of 1-year.

### **1.10 ADMINISTRATION**

- A. All nomenclature shall conform to MBMA Metal Building Systems Manual.
- B. Coordination and administration of work shall be in accordance with MBMA Metal Building Systems Manual – Chapter IV Common Industry Practices.

## **PART 2 PRODUCTS**

### **2.01 FRAMING COMPONENTS**

- A. Materials engineered in accordance with MBMA Manual.
- B. Shop prime framing members which are not fabricated from corrosion resistant material or protected by corrosion resistant finish in accordance with MBMA Manual. Use lead- and chromate-free priming paint.
- C. Control Room Framing: Refer to Section 05 40 00 – Cold-Formed Metal Framing

### **2.02 PREINSULATED METAL PANEL SYSTEMS**

- A. Roof Panels: Refer to Section 07 41 13 – Preinsulated Metal Roof Panels
- B. Wall Panels: Refer to Section 07 42 13 – Preinsulated Metal Wall Panels

### **2.03 ACCESSORIES**

- A. Wall Ladder and Fall Protection Rail System: Refer to Section 05 51 30 – Aluminum Wall Ladder and Platform and Section 05 52 20 – Fall Protection Rail System.
- B. Insulation: Refer to Sections 07 21 13 – Sound Control Batt Insulation, 07 21 20 – Extruded Polystyrene Foam Insulation, and 07 21 50 – Spray-Applied Polyurethane Foam Insulation.

- C. Roof hatches: Refer to Section 07 72 30 – Roof Hatches.
- D. Gypsum Board: Refer to Section 09 29 00 – Gypsum Board
- E. Rubber Wall Base: Refer to Section 09 65 10 – Rubber Wall Base
- F. Louvers and Grilles: Refer to Section 23 37 00 – Air Inlets and Outlets

#### **2.04 DOORS AND DOOR HARDWARE**

- A. Doors and Door Frames: Refer to Section 08 11 10 – Steel Doors and Frames.
- B. Door Hardware: Refer to Section 08 71 00 – Door Hardware.
- C. Roll-Up Doors: Refer to Section 08 33 20 – Roll-Up Doors.

#### **2.05 WINDOWS AND SKYLIGHTS**

- A. Windows: Refer to Section 08 51 20 – Steel Windows
- B. Skylights: Refer to Section 08 62 00 – Unit Skylights

#### **2.06 FABRICATION**

- A. Framing:
  - 1. Fabricate structural members in accordance with MBMA Manual, AISC 303, AISC 325, AISC 360, and AISI S100.
  - 2. Anchor Bolts: Form with straight shank. Assemble with template for casting into concrete.
  - 3. Provide framing for doors, windows, louvers, and other openings.
  - 4. Weld structural steel in accordance with AWS D1.1 or AWS D1.3 as applicable.
- B. Panel Systems:
  - 1. Fabricate panel units in continuous vertical lengths to match building dimensions. Horizontal seams installed in roof and wall systems are not permitted.
  - 2. Provide for thermal expansion and contraction in panel systems without causing buckling, opening of joints, or other damage.

#### **2.07 FINISHES**

- A. Factory finish with colors selected by COR.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify site conditions.
- B. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position and properly squared.
- C. Do not proceed with building erection until unsatisfactory site conditions have been corrected.

### **3.02 ERECTION**

- A. Erect framing in accordance with approved drawings, manufacturer's erection plans and manual, and MBMA Metal Building Systems Manual, Chapter IV Common Industry Practices.
- B. Erect building frame true and level with vertical member's level and bracing properly installed. Maintain structural stability of frame during erection.
- C. Level base plates and secure to anchor bolts to level plane with full bearing to foundation structure:
  - 1. Use nonshrink grout as required for leveling in accordance with Section 03 63 20 – Epoxy Grout.
- D. Ream holes requiring enlargement to admit bolts. Burned holes for bolted connections are not permitted without written approval by design engineer. Burned holes to be reamed.
- E. Tighten bolts and nuts in accordance with "Specification for Structural Joints Using High-Strength Bolts," using specified procedure by building manufacturer.
- F. Erector shall furnish temporary guys and bracing where needed for squaring, plumbing, and securing structural framing against loads, such as wind loads acting on exposed framing and seismic forces, as well as loads due to erection and erection operation, but not including loads resulting from performance of work by others. Bracing furnished by manufacturer for metal building system cannot be assumed to be adequate during erection and are not to be used to pull frames into plumb condition.
- G. Install components in correct position and alignment.
- H. Hold members in place until fastened.
- I. Do not field cut or alter structural members without approval of metal building manufacturer.
- J. Weld structural steel in accordance with AWS D1.1 and weld sheet metal in accordance with AWS D1.3.

- K. After erection, erector to prime welds, abrasions, and surfaces not shop primed or needing touch-up.
- L. Install wall and roofing systems in accordance with Sections 07 41 13 - Preinsulated Metal Roof Panels, 07 42 13 - Preinsulated Metal Wall Panels and manufacturer's instructions.
- M. Fasten Cladding system to structural supports, using proper fasteners aligned level and plumb.
- N. Set purlins and girts at right angle and bolt to appropriate clips. Attach to clips as required to satisfy design loads and as shown on drawings.
- O. Place screw down roof panels at right angle to purlins and girts. Attach and plumb wall panels as shown on drawings. Maintain consistent module coverage for entire length of wall. Place end laps over purlins or girts. Apply manufacturer's roof panel side and end lap sealant between panel ends and side laps to provide water-tight installation per details furnished.
- P. Place preinsulated metal roof panels at right angle to purlins. Attach with sliding concealed clip where expansion and contraction must be accounted for. Place end laps above purlin with backup plate so panel end-lap fasteners do not penetrate purlin. Follow manufacturer's instructions for fastening and sealing end laps.
- Q. Install gutters and downspouts, roof and gutter de-icing, flashings and trim in accordance with Section 07 41 13 – Preinsulated Metal Roof Panels. Place splashblocks (Refer to Section 07 41 13 – Preinsulated Metal Roof Panels) at bottom of downspouts.
- R. Install door frames, doors, and roll-up doors in accordance with manufacturer's instructions.
- S. Trim, close, and seal building weathertight.

### **3.03 COATING**

- A. Refer to Section 09 96 20 – Coatings.

### **3.04 REPAIR**

- A. Touch-up paint minor scratches and abrasions to finish in accordance with manufacturer's instructions. Use matching paint furnished by manufacturer.
- B. Replace materials with damaged finish detrimental to appearance.

### **3.05 CONTRACTOR QUALITY CONTROL**

#### **A. Field Water Test:**

1. Roof Panels: Refer to Section 07 41 13 – Preinsulated Metal Roof Panels
2. Wall Panels: Refer to Section 07 42 13 – Preinsulated Metal Wall Panels

#### **B. Protection, Repair, and Cleaning:**

1. Roof Panels: Refer to Section 07 41 13 – Preinsulated Metal Roof Panels
2. Wall Panels: Refer to Section 07 42 13 – Preinsulated Metal Wall Panels

**END OF SECTION**

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**SECTION 21 22 00**  
**CLEAN AGENT FIRE EXTINGUISHING SYSTEMS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Clean Agent Fire Extinguishing System:
1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

- A. American Society of Civil Engineers (ASCE)
1. ASCE 7-2016 Minimum Design Loads for Buildings and Other Structures
- B. American Society Of Mechanical Engineers (ASME)
1. ASME BPVC IX-2017 Boiler and Pressure Vessel Code - Section IX - Welding and Brazing Qualifications
  2. ASME B31.9-2014 Building Services
  3. ASME B31.1-2016 Power Piping
- C. ASTM International (ASTM)
1. ASTM A53/A53M-12 Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
  2. ASTM A106/A106M-15 Seamless Carbon Steel Pipe for High-Temperature Service
  3. ASTM A197/A197M-00 (2015) Cupola Malleable Iron
  4. ASTM E779-10 Determining Air Leakage Rate by Fan Pressurization
- D. Federal Register Volume 59, EPA SNAP Program
- E. National Fire Protection Association (NFPA)
1. NFPA 2001 - 2015 Clean Agent Fire Extinguishing Systems
- F. Manufactures Standards Society (MSS)
1. MSS-SP-58 Pipe Hangers and Supports

### 1.03 SYSTEM DESCRIPTION

#### A. Design Requirements:

1. Design, furnish and install for area described below, fixed fire suppression extinguishing system of total flooding type utilizing FK-5-1-12 - Dodecafluoro-2-methylpentan-3-one (NOVEC 1230) halocarbon clean agent to an operating pressure of 360 pounds per square inch (psi) at 95 degrees F, or approved equal.
2. Protect Control Room as a zone. Zone shall have main supply of clean agent only; reserve supply is not required. Locate clean agent cylinder(s) and appurtenances against exterior wall of Control Room adjacent to control room doors.
3. Developed pressurization/depressurization in zone due to release of clean agent shall not exceed 5-psi. Provide venting to prevent excessive pressures. Designers shall consult with system manufacturer's recommended procedures relative to enclosure venting.
4. System shall be released automatically by Fire Alarm Suppression Panel (FASP) (see Section 28 31 00 – Fire Detection and Alarm).
5. Comply with requirements and recommendations of NFPA 2001 for design, fabrication, and installation of fire suppression extinguishing system and its components. Meet approval of Factory Mutual Research Corporation (FM) and/or Underwriters Laboratories (UL) for design and installation of system.
6. Design flame extinguishing concentration for Class A and C hazard.
7. Size system to provide required room concentration levels of clean agent, but not to exceed lowest observable adverse effect level as defined by NFPA 2001. Design system to discharge its contents between minimum of 5-seconds and maximum of 10-seconds.

#### B. Site Conditions:

1. Temperature of Control Room varies from approximately 60 to 80 degrees F.
2. Control Room will typically be unoccupied.
3. Room shall have air-conditioning unit and lighting fixtures suspended from ceiling. Piping shall avoid these devices.

### 1.04 SUBMITTALS

#### A. Submit the following in accordance with Section 01 33 00 – Submittals.

#### B. RSN 21 22 00-1, Approval Drawings and Data:

1. Drawings and data required by Navajo Nation Fire Marshal for issuance of permit:
  - a. Signed and stamped by approving official at State of New Mexico.

2. Commercial product data for each piece of equipment comprising system including storage cylinders, valves, pressure sensors, room vents (if required) and other appurtenances.
  3. Drawings and data:
    - a. Shop drawings indicating detailed layout of system locating each component including clean agent cylinders, piping, seismic restraints, pipe supports, anchorage, dampers and fire door (as applicable).
    - b. Complete hydraulic flow design calculations derived from UL listed computer program written specifically for clean agent used, unless system is pre-engineered. Include analysis calculations to verify system terminal pressures, nozzle flow rates, orifice code number, piping pressure losses, component flow data, and pipe sizes considering actual and equivalent lengths of pipe and elevation changes. Total agent discharge time must be shown and detailed by zone.
    - c. Calculations showing developed pressures of agent discharge in zone, enclosure wall and roof structural strength and venting calculations (if venting is required).
    - d. Calculations showing project specific design of pipe hangers, lateral and longitudinal braces and their supports.
    - e. Manufacturer's installation instructions.
    - f. List of local companies that can service NOVEC 1230 clean agent system and refill tanks.
  4. Test Plan describing procedures to be used to test suppression system.
- C. RSN 21 22 00-2, Final Drawings and Data:
1. As-built drawings:
    - a. Provide full size drawings in Government Format, see requirements in Section 01 33 00 – Submittals.
    - b. Provide CDs in AutoCAD format.
  2. Bound service manual which includes:
    - a. All submitted data previously approved in RSN 21 22 00-1 above.
    - b. Half-size (11- by 17-inch) prints:
      - 1) As-built drawings.
    - c. Written description of system design.
    - d. Maintenance schedule in tabular form.
    - e. Schematic and wiring diagrams.
- D. RSN 21 22 00-3, Test Reports:
- a. Test reports after successful completion of tests.

## 1.05 REGULATORY REQUIREMENTS

- A. Obtain permit for the clean agent fire extinguishing system from Navajo Nation Fire Marshal's office:
1. Comply with State of New Mexico requirements for review and approval of design and installation.
  2. Arrange for required field inspections of work by Navajo Nation Fire Marshal:
    - a. Coordinate inspections with COR.
    - b. Notify COR, in writing, of date and time of each inspection at least 7-days before scheduled date of inspection.
  3. Pay required fees to:

Navajo Nation Department of Fire & Rescue Services  
Fire Chief; Larry Chee  
PO Box 3360  
Window Rock, AZ 86515  
Telephone: 928-871-6915  
Fax: 928-871-6917  
[www.firerescue.navajo-nsn.gov/](http://www.firerescue.navajo-nsn.gov/)

## 1.06 QUALIFICATIONS

- A. Designer:
1. Professional engineer registered in State of New Mexico, experienced in design of this type.
  2. Authorized and certified by equipment manufacturer to determine requirements of clean agent fire extinguishing system utilizing manufacturer's equipment.
- B. Manufacturer:
1. Company specializing in manufacturing products specified in this section with minimum 3-years documented experience.
- C. Installer:
1. Provide manufacturer's certified technician with minimum National Institute for Certification in Engineering Technologies (NICET) Level III certification to supervise installation, adjustment and final connections. Installer shall be trained by manufacturer to install and test clean agent fire extinguishing systems.
- D. Welding Procedures, Welders, and Welding Operators:
1. Section IX of ASME BPVC
  2. Make welding certifications available at request of COR.

## **1.07 TRAINING OF GOVERNMENT PERSONNEL**

- A. Furnish training on operation, testing and maintenance of clean agent fire extinguishing suppression system for four designated operation and maintenance personnel within three weeks after completion of contract. Conduct training on-site. Coordinate time and date of training with COR.

## **1.08 MAINTENANCE SERVICE**

- A. Inspect system 6-months and 11-months after system acceptance:
1. Perform inspections per NFPA 2001.
  2. At conclusion of each inspection, provide plant personnel with completed inspection report. Include in report description of any repairs and/or adjustments performed on system.
  3. Perform annual maintenance at 11-month inspection.

## **PART 2 PRODUCTS**

### **2.01 PIPE AND PIPING**

- A. General:
1. Steel pipe: ASTM A53 seamless, Grade A or B or ASTM A106, Grade A, B, or C, Schedule 40, galvanized:
    - a. Verify piping materials with internal pressure of 360 psi will not cause material stress greater than material's yield point when calculated according to ASME B31.1.
  2. Pipe fittings: ASTM A197, Class 300 malleable or ductile iron galvanized fittings:
    - a. Two inches and smaller: Threaded fittings.
    - b. 2 1/2-inches and larger: Flanged or grooved connections.
  3. Provide all new pipe and fittings of recent manufacture.
  4. Pressure Release Piping and Fittings:
  5. Reduction in pipe size not allowed between discharge piping connection and relief valve.
  6. Provide all take-offs for pressure release piping from top of discharge piping.
- B. Pipe Hangers and Supports:
1. Provide pipe hangers and supports in accordance with the provisions outlined in ASME B31.9.

2. Design hangers and supports to meet ASCE 7 Chapter 13 - Seismic Design Requirements for Nonstructural Components. Seismic design criteria is shown on drawing 1695-D-60399. Provide rigid hangers wherever change in direction or change in elevation in piping system occurs. Furnish rigid hanger for at least every other hanger on long straight runs.
  3. Fabricate all hangers from steel.
  4. Design hangers and pipe to prevent stresses from being induced into piping during temperature change caused by clean agent system discharge.
  5. Fabricate all piping supports so that they will not be disengaged by movement of supported pipe.
  6. Do not use one pipeline as support for another.
- C. Sleeves:
1. Sleeves for pipes through non-fire rated walls: Form with steel pipe or No. 18 United States Standard Steel gauge galvanized steel.
- D. Wall Seal:
1. FD/FS Link-Seal Modular Seal as manufactured by Pipeline Seal & Insulator, Incorporated, Houston, TX; or equal, having the following essential characteristics:
    - a. Modular, water tight, mechanical seal, consisting of inter-locking, synthetic rubber links shaped to continuously fill annular space between pipe and wall opening.
    - b. Stainless steel or zinc plated hardware.
    - c. UL listed or FM approved.

## **2.02 CLEAN AGENT SYSTEM COMPONENT REQUIREMENTS**

- A. Cylinders:
1. Provide cylinder assemblies which conform to regulations of the United States Department of Transportation. Fit cylinders with resilient pressure seat type forged brass valve which has threaded steel anti-recoil protective cap for handling and shipment.
  2. Provide liquid level measuring device.
- B. Discharge Valves:
1. Equip each cylinder with pressure operated discharge valve. Provide each valve with integral safety relief device to protect cylinder against excessive internal pressure.
  2. Furnish cylinder valve with forged brass body with external connections for actuation devices. Provide each valve with removable pressure gauge or solenoid valve with gauge for pressure reading.

3. Provide check valve with each cylinder when more than one cylinder is connected to common manifold. Do not utilize check valves with "O" ring seats since they can be dislodged during discharge.
- C. Switches:
1. Factory Mutual (FM) Global approved or National Recognized Tested Laboratories (NRTL) listed, where available, 120-Vac or low voltage compatible with controls. Include contacts for connection to control panel. Include tamper switch and pressure switch as required.
- D. Distribution System:
1. Lay out piping for maximum flow and to avoid possible mechanical, chemical or other damage.
- E. Nozzles:
1. Supply nozzles in quantities sufficient to properly cover the areas being protected in accordance with NFPA 2001.
  2. Furnish nozzles of corrosion resistant construction designed specifically for clean agent application.
  3. Permanently mark nozzles as to type and orifice.
- F. Agent:
1. Provide FK-5-1-12 – Dodecafluoro-2-methylpentan-3-one (NOVEC 1230) halocarbon clean agent gas meeting the requirements of NFPA 2001, or equal with the following characteristics:
    - a. Dry, non-corrosive, non-damaging and non-deteriorating.
    - b. Agent suitable for use in normally occupied spaces.
    - c. Agent shall not contain any hydrofluorocarbons.
    - d. Agent in container super pressurized with nitrogen to maximum working pressure of 360 psia.
    - e. Ozone Depletion Potential of Zero (0).
    - f. Atmospheric Lifetime less than 1-year.
    - g.  $LC_{50} > 800,000$  ppm.
    - h. Agent listed as "Acceptable" on EPA's Significant New Alternatives Policy (SNAP) list.
- G. Controls and Accessories:
1. Provide controls and accessories in accordance with Section 28 31 00 - Fire Detection and Alarm System.

**H. Nameplates:**

1. Furnish nameplates for equipment, devices and instrumentation components of system.
2. Fabricate nameplates from laminated phenolic resin material conforming to the requirements listed on standard drawing 40-D-6234. Minimum 3/32-inch thickness for nameplates mounted on flat surfaces. Minimum 3/16-inch thickness for nameplates mounted on piping or other non-flat surfaces.
3. Lettering:
  - a. White lettering and red background.
  - b. Size: 3/16-inch.
4. Fasteners:
  - a. Non flat surfaces - Minimum 16 gauge stainless steel wire tie for nameplates.
  - b. Panel mounted - Self threaded corrosion resistant screws.

**2.03 COATINGS**

- A. Provide coatings for clean agent fire extinguishing system in accordance with Section 09 96 20 - Coatings.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Field verify dimensions of protected space, pertinent existing equipment and building floor-space before starting work.
- B. Install system in accordance with NFPA 2001, as shown on drawings, and as recommended by major equipment manufacturer.
- C. Mount clean agent cylinders vertically. Support cylinders with cylinder mounting straps. Arrange cylinders to allow for cylinder removal and inspection of tank volume and pressure.
- D. Install union immediately downstream of all threaded valves. Install union adjacent to valve in each connection line for threaded valves having more than two connection points. Install union adjacent to equipment pipe connections such as pressure switches, etc.

**3.02 CONSTRUCTION**

- A. Pipe and Piping:
  1. Pipe, Fittings and Joints:

- a. Ream all pipe after cutting so that all burrs and sharp edges are removed.
  - b. Clean all pipe thoroughly before installation. Pull wire flue brush through length several times, followed by clean cloth rags treated with noncombustible metal cleaner designed for purpose. Remove all foreign matter and oil by this process. Repeat process until pipe is clean and all contaminants are removed.
  - c. Thread preparation: Coat all threaded pipe with an appropriate pipe joint compound or Teflon tape. When pipe joint compound is used, coating of threads must start at least two threads back from pipe end. Take care on small piping not to allow sealant to enter valves or controls.
2. Welding:
- a. Use gas welding or other approved method on all welded pipe 3/4-inch and smaller. Unshielded electric arc welding may be used on pipe larger than 3/4-inch.
  - b. Pound all welds to loosen scale and weld beads and then clean.
3. Pipe Reductions: Install to permit full flow in each case. All entrance holes from main pipe run to fitting must be of proper size and free of sharp edges, ridges or burrs. Use one of the following devices when making reductions in pipe:
- a. Welded - Butt weld concentric reducers or weld-o-lets.
  - b. Grooved - Commercially available grooved concentric reducers.
4. Reductions - Threaded Pipe:
- a. Provide threaded concentric reducing fittings for all reductions in threaded pipe.
5. Pipe Sleeves:
- a. Provide pipe sleeve at least two sizes larger than pipe.
  - b. Seal around pipe with mechanical seal to prevent clean agent loss and/or leakage.
  - c. Sufficient length to pass through entire thickness of walls.
6. Pipe Hangers and Supports:
- a. Attach all piping to rigid hangers by means of U-bolts locked with double nuts, one on each side of hanger. Allow pipe to be free to move longitudinally within U-bolt except where piping design requires it to be anchored.
  - b. Install all piping supports so that they will not be disengaged by movement of supported pipe.
  - c. Arrange piping supports so that no excessive bending stresses are induced into piping from concentrated loads between supports.

- d. Install pipe hangers and supports in accordance with ASME B31.1 and MSS SP 58.
  - e. Provide additional hangers and supports wherever concentrated loads from valves or heavy fittings occur, or at changes in direction of piping.
7. Nameplates:
- a. Do not use adhesive for attaching nameplates.

### **3.03 CONTRACTOR FIELD QUALITY TESTING**

- A. Notify COR, in writing, of date and time fire protection systems will be ready for testing, at least 10-days before tests are to be conducted. Include proposed period of time required for complete testing.
- B. Test Plan shall include step-by-step description of all tests to be performed and shall indicate type and location of test apparatus to be employed. Tests shall demonstrate that operational and installation requirements of this specification have been met.
- C. Provide service of manufacturer's certified technician with minimum NICET Level III certification, or factory trained engineer authorized by manufacturer to technically supervise and participate during all of adjustments and tests for system. All tests shall be witnessed by Government.
- D. Test distribution piping pneumatically for period of 10-minutes at 40 psig. At end of 10-minutes, pressure drop shall not exceed 20 percent of test pressure.
- E. Perform an enclosure integrity test using door fan method of room pressurization for zone to determine leakage. Integrity test procedure shall be in accordance with NFPA 2001. Hold period shall be minimum of 10-minutes. Guidance regarding fan pressurization apparatus design, maintenance and operation is provided by ASTM E779. Contractor shall be responsible for sealing Control Room against clean agent loss and/or leakage.
- F. Perform operational test using door fan method of room pressurization for zone to demonstrate operation and sizing of pressure relief dampers. Coordinate test with HVAC contractor.
- G. Make repairs or install replacement components, when any defects are detected, and repeat tests as required.
- H. Thoroughly test system upon completion of installation for correct operation and function. Include functional operation tests of all mechanical equipment and careful inspection of all piping and nozzles. Conduct flow test of short duration, also known as puff test, with nitrogen to determine that flow is continuous and that all piping and nozzles are free of obstructions.
- I. Provide complete written test reports of all tests performed with at least the following information:

1. Date, time, and location of tests.
  2. Names and signatures of witnesses to tests.
  3. Room, dimensions and volume.
  4. All data generated during tests, including computer printouts.
  5. Descriptions of any special techniques utilized by test technician.
  6. Test equipment make, model, and serial number.
  7. Copy of current calibration, certificate of test equipment.
  8. Name and affiliation of testing technician, and signature.
- J. After testing, system shall be in full operation condition.

**END OF SECTION**

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**SECTION 22 11 10**  
**PLANT AUXILIARY WATER SYSTEMS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Plant Auxiliary Water Systems:

1. Payment: Lump sum prices offered in Price Schedules 1 (Pumping Plant No. 4).

**1.02 REFERENCE STANDARDS**

A. American Society of Mechanical Engineers (ASME)

- |    |                   |  |
|----|-------------------|--|
| 1. | ASME A13.1-2015   | Scheme for the Identification of Piping Systems                |
| 2. | ASME B1.20.1-2013 | Pipe Threads   |
| 3. | ASME B16.18-2018  | Cast Copper Alloy Solder Joint Pressure Fittings               |
| 4. | ASME B16.22-2018  | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| 5. | ASME B40.100-2013 | Pressure Gauges  |
| 6. | ASME B40.200-2008 | Thermometers, Direct Reading and Remote Reading                |

B. ASTM International (ASTM)

- |    |                   |                            |
|----|-------------------|----------------------------|
| 1. | ASTM B32-08(2014) | Solder Metal               |
| 2. | ASTM B88-16       | Seamless Copper Water Tube |

C. American Society of Sanitary Engineers

- |    |                |   |
|----|----------------|---|
| 1. | ASSE 1015-2011 | Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies |
|----|----------------|---|

D. American Water Works Association (AWWA)

- |    |              |   |
|----|--------------|---|
| 1. | AWWA C510-17 | Double Check Valve Backflow Prevention Assembly |
|----|--------------|---|

E. American Welding Society (AWS)

- |    |                           |   |
|----|---------------------------|---|
| 1. | AWS A5.8M/A5.8:2011-AMD-1 | Filler Metals for Brazing and Braze Welding |
|----|---------------------------|---|

- F. Commercial Item Description (CID)
  - 1. CID A-A-1923A-1995 Shield Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
- G. Manufacturers Standardization Society (MSS)
  - 1. MSS SP-80-2013 Bronze Gate, Globe, Angle and Check Valves
  - 2. MSS SP-110-2010 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
  - 3. MSS SP-58-2018 Pipe Hangers and Supports
- H. National Electric Manufacturers Association (NEMA)
  - 1. NEMA 250-2018 Enclosures for Electrical Equipment
- I. New Mexico Plumbing Code 2012
- J. NSF International
  - 1. NSF 61-2016 Drinking Water System Components
- K. Uniform Plumbing Code (UPC)
  - 1. UPC-2018 2018 Uniform Plumbing Code

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals:
- B. RSN 22 11 10-1, Approval Data and Drawings:
  - 1. Commercial product data including catalog illustrations, sizes, material, pressure ratings, manufacturer's installation instructions and complete parts lists for the following:
    - a. Piping
    - b. Valves
    - c. Pipe Hangers and Supports.
    - d. Accessories.
  - 2. Drawings showing materials and dimensions of the complete water systems in Plan and Section views.
- C. RSN 22 11 10-2, Final Drawings and Data:
  - 1. Operation and Maintenance Manuals, in booklet form:

- a. Submit complete installation, operation and maintenance manuals, including:
  - 1) Maintenance data and schedules.
  - 2) Description of operation and spare parts information.
  - 3) All previously approved data submitted under RSN 22 11 10-1.
  - 4) Any applicable test records or reports.
  - 5) 11- x 17-inch half sized drawings.
- 2. Test Report
- 3. As-Built drawings.
  - a. Provide drawings in Government Format in .pdf and AutoCAD format.

#### **1.04 SYSTEM DESCRIPTION**

- A. Pumping Plant No. 4 and Chemical Building:
  - 1. Provide piping and connections for:
    - a. Chemical Building emergency water system in accordance with Section 22 45 00 – Emergency Plumbing Fixtures:
      - 1) Water supply is from the suction manifold as shown on drawings.
      - 2) Water is supplied at a pressure of 18-psi minimum.
      - 3) Allowable pressure range at the safety shower is 30-psi to 80-psi.
- B. Furnish and install all components including all piping, valves, fittings, gages, and appurtenances to provide a complete operational system.

### **PART 2 PRODUCTS**

#### **2.01 PIPING AND APPURTENANCES**

- A. Copper Piping:
  - 1. ASTM B88 Type K, drawn temper.
  - 2. Fittings:
    - a. ASME B16.18, cast copper alloy.
    - b. ASME B16.22, wrought copper and bronze.
  - 3. Solder joints:
    - a. Provide for joints 2-inches and smaller.
    - b. ASTM B32, solder, Grade 95-5 Tin Antimony.
  - 4. Brazed joints
    - a. Brazed joints made with flux are acceptable for all line sizes.
    - b. Brazing material per AWS A5.8, class BCuP-3.

B. Dielectric Fittings:

1. Dielectric Unions: Factory-fabricated union assembly, with appropriate pressure rating for location in system. Include insulating material that isolates dissimilar metals and ends with inside threads.
2. Dielectric Flanges: Factory-fabricated companion-flange assembly, with appropriate pressure rating for location in system.

C. Pressure Gauge:

1. Standard: ASME B40.100.
2. Case: Sealed type(s); cast aluminum or drawn steel; 4 1/2-inch nominal diameter.
3. Pressure-element assembly: Bourdon tube unless otherwise indicated.
4. Pressure connection: Brass, with NPS 1/4 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
7. Range: 0 - 100-psi.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

D. Flexible Metal Connections:

1. Flexible seamless hose reinforced with stainless steel wire braid with threaded ends.
2. Same diameter as discharge piping with a length not less than 9-inches.
3. Suitable for pulsating service at working pressure not less than 150-psi at 100 degrees F.
4. Pressure rating: Marked on outside of hose.

E. Temperature Indicator:

1. Standard: ASME B40.100.
2. Case: Sealed type(s); cast aluminum or drawn steel; 4 1/2-inch nominal diameter.
3. Dial: Non-reflective aluminum with permanently etched scale markings graduated in degrees F.
4. Pointer: Dark-colored metal.
5. Window: Glass or plastic.

6. Ring: Metal.
7. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
5. Range: 0 to 120 degrees F.
6. Bimetal thermometer.
7. At locations shown on drawings.

F. Wye-strainers:

1. Brass components.
2. Class 150 threaded ends.
3. For water heater: Filtration to 40-microns or as recommended by water heater manufacturer.
4. Maximum pressure drop across filter 10-psi.

G. Pressure Switch:

1. 100-psi pressure rating.
2. NEMA 4X housing.
3. 316L stainless-steel pressure module.
4. 4-20 mA.
5. 9 to 30-Volt DC supply voltage.
6. 1/4-inch female NPT pressure connection.
7. 1/2-inch male conduit electrical fitting.

## 2.02 VALVES

A. Check valves:

1. Bronze, class 150, swing type with metal disc and seat per MSS SP-80.
2. Threaded per ASME B1.20.1.
3. Lead free per NSF/ANSI 61.
4. Swing type.

B. Ball Valves:

1. Two-piece body, bronze ball valve per MSS SP-110.
2. Seats: PTFE or TFE.
3. Full port, 1/4 turn.
4. Pressure Rating:
  - a. Discharge header shut off valve: 300-psi cold working pressure.

- b. All other ball valves: 150-psi cold working pressure.
- 5. Threaded per ASME B1.20.1 or soldered per ASME B16.18.
- 6. Lead free per NSF/ANSI 61.
- C. Double Check Backflow Valve Assemblies:
  - 1. Threaded per ASME B1.20.1.
  - 2. Bronze body.
  - 3. Working pressure 175-psi.
  - 4. Meets ASSE 1015 and AWWA C510.
- D. Root Valves
  - 1. Meets MSS-SP-99.
  - 2. Compression fittings.
  - 3. Bronze body.
  - 4. Lead free.

### **2.03 PIPE HANGERS AND SUPPORTS**

- A. Pipe Hangers for Copper Tube:
  - 1. Hangers for tube sizes 1/2-inch to 1 1/2-inches: Carbon steel, adjustable tubing ring and malleable iron adjusting nut, both plated with copper-plated finish.
  - 2. Hangers for tube sizes 2- to 4-inch: Carbon steel, adjustable clevis with copper-plated finish.
  - 3. Per MSS SP-58.
- B. Pipe Supports:
  - 1. Copper-plated carbon steel or malleable iron split tubing clamp.
- C. Beam C-Clamps:
  - 1. Use where piping is suspended from building steel.
  - 2. Clamp type: Select on the basis of load supported and load configuration.
  - 3. C-Clamps: Provide locknuts and cup point set screws.
  - 4. Top flange C-clamps: Use when attaching hanger rod to top flange of structural shapes.
- D. Hanger rods: Threaded on both ends or continuously threaded rods of circular cross section. No wire, chain, or perforated straps allowed.

- E. Expansion Anchors:
  - 1. Expansion anchors in accordance with CID A-A-1923A, Type 4, stainless-steel anchors with 3 1/2-inch minimum embedment bolt length.

## **2.04 ACCESSORIES**

- A. Sleeves: Form sleeves for pipes through walls and floor slabs with steel pipe or No. 18 United States Standard Steel gauge galvanized steel.
- B. Escutcheons:
  - 1. Chrome-plated finish.
  - 2. Removable, split- type.
- C. Plastic Tape Pipe Markers:
  - 1. Flexible, colored vinyl film tape with pressure sensitive adhesive backing compatible with pipe and insulation.
  - 2. Printed markings identifying service, flow direction, and pressure in accordance with ASME A13.1.
- D. Nameplates:
  - 1. Provide for equipment, valves, and non-potable water hose bibs.
  - 2. Fabricate from brass:
    - a. Minimum thickness 0.063-inch.
  - 3. Lettering:
    - a. White paint or laser etching.
    - b. Size: 1-inch.
  - 4. Fasteners: Self-threading corrosion-resistant screws.
  - 5. Chains: Stainless-steel construction.
  - 6. Cables for valves.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. General:
  - 1. Provide dielectric connections wherever joining dissimilar metals. Locate unions in accessible places.
  - 2. Make change in directions with pipe fittings.

3. Protection:
  - a. Plug or cap open ends of pipe at end of each work day or other stopping point throughout construction.
  - b. Tightly cover equipment and protect against dirt, water, chemical, or mechanical damage.
- B. Emergency water system: Install in accordance with New Mexico Plumbing Code.
- C. Copper Tubing:
  1. Clean outside surface of copper tubing that contacts fittings and inside surfaces of fittings with abrasive material prior to making connections.
  2. Prevent annealing of tube or fittings when making soldered or brazed connections.
  3. When brazing connections of 2 1/2-inch and larger tubing, apply heat uniformly around entire circumference of tube and fittings with multi-flame torch.
  4. Wipe excess flux, solder, or brazing material off exterior of tubing and fittings before it hardens.
  5. Avoid applying excess flux, solder, or brazing material to inside surface of tubes or fittings.
  6. Cut tubes square and ream to remove burrs.
  7. Fittings and connections:
    - a. Bushings not permitted. Make changes in pipe sizes with fittings.
    - b. Provide dielectric connections wherever joining dissimilar metals, and locate in accessible places.
    - c. Install unions downstream of valves, equipment connections, or apparatus connections.
- D. Escutcheons: Provide at finished surfaces where bare or insulated piping passes through floors, walls, or ceilings.
- E. Provide sleeves for pipes passing through partitions, walls and floors.
- F. Anchors and Supports:
  1. Install anchors and supports per MSS SP-58.
  2. Anchor supply pipes for fixtures, faucets, and valves.
  3. Maximum spacing between pipe hangers and supports for copper tubing per UPC.
- G. Plastic Tape Pipe Markers:
  1. Install appropriate plastic tape pipe markers for all exposed piping components, valves, and equipment.
  2. Install identifying devices after completion of insulation, coverings, and painting.

3. Align with axis of piping. Install completely around pipe with markings in clear view.
4. Distance between identification: Not to exceed 20-feet on centers on straight runs, including risers and drops.
5. Provide adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

H. Nameplates:

1. Install nameplates indicating valve name or purpose indicated on drawings.
2. Chains or cables shall be provided if valve size or insulation interferes with nameplate installation.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

A. General:

1. Notify COR in writing at least 14 working days prior to testing. Include the following:
  - a. Copy of approved test plan.
  - b. Date and time system shall be ready for testing.
  - c. Period required to complete testing.
2. All tests shall be witnessed by COR.
3. Test new piping systems after installation:
  - a. Furnish materials, supplies, labor, and equipment required for tests including temporary flanges and plugs required for tests.
  - b. Disconnect or isolate instruments and equipment that are not designed for test pressures prior to testing piping and reconnect after testing.
  - c. Inspect, test and repair work to be concealed and covered prior to concealing or covering.
4. Subject systems to operating tests to demonstrate function and operation to satisfaction of COR by operating each device.
5. Perform water leakage pressure test with water pressurized to 150-lb/in<sup>2</sup>. Maintain pressure in each piping system for not less than 3-hours without leaks. Repair leaks in manner approved by COR. Retest after repairs:
  - a. Remove pressure reducing valve prior to test and reinstall after test is complete.
  - b. Use calibrated Grade A pressure gauges.

### **3.03 CLEANING OF WATER SYSTEMS**

- A. Flush piping after pressure tests are completed. Continue flushing until discharge water shows no discoloration.

- B. Drain system at low points. Direct flow into gravity drainage system.
- C. Remove, clean, and replace screens at eye-washes, and any other strainers. After flushing and cleaning, prepare systems for service by immediately filling piping with clean, fresh, potable water.
- D. Repair any stoppage, discoloration, damage to finish, furnishings, or parts of building due to failure to properly clean piping system.
- E. Flush and disinfect system in accordance with New Mexico Plumbing Code.

**END OF SECTION**

**SECTION 22 13 16**  
**PLANT GRAVITY DRAINAGE PIPING SYSTEMS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Plant Gravity Drainage Piping Systems:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American Society of Mechanical Engineers (ASME)

1. ASME A112.6.3 – 2019 Floor and Trench Drains

B. ASTM International (ASTM)

1. ASTM A74-2017 Cast Iron Soil Pipe and Fittings
2. ASTM A888-2018a Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
3. ASTM C564-2014 Rubber Gaskets for Cast Iron Soil Pipe and Fittings

C. Commercial Item Descriptions (CID)

1. CID A-A-1923A-1995 Shield Expansion (Lag, Machine and Externally Threaded Wedge Bolt) Anchors

D. Cast Iron Soil Pipe Institute (CISPI)

1. CISPI 301-2018 Couplings for Use in Connection with Hubless Cast Iron Sanitary and Storm Drain, Waste and Vent Piping Applications

E. Deutsches Institut für Normung E.V. (DIN), German Institute of Standards

1. DIN EN1433-2005 Drainage channels for vehicular and pedestrian areas - Classification, design and testing requirements, marking and evaluation of conformity
2. DIN 19580-2010 Drainage channels for vehicular and pedestrian areas - Durability, mass per unit area and evaluation of conformity

- F. Manufacturers Standardization Society (MSS)
  - 1. MSS SP-58-2018 Pipe Hangers and Supports
- G. New Mexico Plumbing Code 2015

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 22 13 16–1, Approval Drawings and Data:
  - 1. Manufacturer’s literature, specifications, and engineering data including dimensions, size, and material of the following:
    - a. Piping and fittings.
    - b. Floor and equipment drains.
  - 2. Drawings at 1/4-inch per foot scale showing materials and dimensions of complete piping system, in Plan and Section views.
  - 3. Test Plan:
    - a. Detailed test plan including step by step instructions, time estimates, and list of required equipment.
- C. RSN 22 13 16-2, Final Drawings and Data:
  - 1. Operation and Maintenance Manuals, in booklet form:
    - a. Submit complete installation, operation and maintenance manuals, including:
      - 1) Maintenance data and schedules.
      - 2) Description of operation and spare parts information.
      - 3) All previously approved data submitted under RSN 22 13 16-1.
      - 4) Half size (11- by 17-inch) as built drawings.
      - 5) Any applicable test records or reports.
  - 2. Test results.
  - 3. As-built Drawings:
    - a. Provide full size drawings in Government Format, see requirements in section 01 33 00 – Submittals.
    - b. Provide CDs in AutoCAD format.

### **1.04 DESIGN REQUIREMENTS**

- A. Exposed gravity drain piping runs within interior of building shall be hubless cast iron. Concealed gravity drain piping lines shall be service weight cast iron soil pipe with hub and spigot connections.

- B. Piping located in concrete slabs or underground to exterior limits as shown on drawings shall be service weight cast iron soil pipe with hub and spigot connections.

## **1.05 QUALIFICATIONS**

- A. Manufacturer's Qualifications:
  - 1. Minimum 5-years of experience producing substantially similar equipment, and be able to produce evidence of at least 5 installations in satisfactory operation for at least 5-years.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. Provide adapters, as required.

### **2.02 HUB AND SPIGOT CAST IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A74.
- B. Weight: Service Weight.
- C. Hub and Spigot Compression Type Joints:
  - 1. Gasket: Neoprene Rubber, ASTM C564.
  - 2. Lubricant: As recommended by pipe manufacturer.

### **2.03 HUBLESS CAST IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A888.
- B. Joints: CISPI 301.

### **2.04 DRAINS**

- A. Heavy Duty Trench Drain System:
  - 1. Modular Trench Drains:
    - a. Fiber Reinforced Polymer, High Density Polyethylene or Polyester Concrete Trench Drains with interlocking joints, and slope-invert.
    - b. Positive mechanical connection between channels that will not separate during installation and mechanically lock into the surrounding concrete.
    - c. Slope: Minimum Trench slope of 0.5 percent.
    - d. Frame: Heavy Duty Galvanized or Ductile Frame Assembly.
    - e. Dimensions: 6-inch wide and 4-inch throat

- f. Grating: Class C per DIN EN1433/DIN 19580 top load classifications.
- g. Covers: Solid Galvanized Ductile Iron, of width and thickness that fit recesses in channel section and of lengths required.
- h. Supports, anchors and setting devices: Manufactory standard.
- i. Maximum trench depth of 5 1/2-inches
- j. Accessories:
  - 1) Outlet Adapters: 4-inch hubless, bottom or end outlet.
  - 2) Closed End Caps.
  - 3) Joint Connectors.
  - 4) Rebar Clips as required.

**B. Indirect Waste Floor Drain (Condensate drain receptor).**

- 1. Roof-ceptor® Indirect Waste Drain Figure 3960 manufactured Jay R. Smith Mfg. Co. 2781 Gunter Park Dr. East, Montgomery, AL 36109-1405, 1-334-277-8520; or equal, having the following essential characteristics:
  - a. Materials:
    - 1) Body: Cast iron.
    - 2) Bottom Strainer: Cast Iron
  - b. Outlet Connection: 4-inch Bottom outlet, caulk or hubless, as required.
  - c. Solid water dam to prevent storm water from entering drain, minimum height 2-inches
  - d. Vandal proof dome bottom strainer.

**C. Floor Drain**

- 1. Floor Drain:
  - a. Materials:
    - 1) Body: Cast iron.
    - 2) Bottom Strainer: Cast Iron.
  - b. Outlet Connection: 4-inch bottom outlet, caulk or hubless, as required.
  - c. Vandal proof dome bottom strainer.

**2.05 PIPE HANGERS AND SUPPORTS**

**A. Pipe Hangers and Supports:**

- 1. Galvanized zinc plated carbon steel or malleable iron in accordance with MSS SP-58.

- B. Expansion Anchors:
  - 1. Expansion anchors in accordance with CID A-A-1923A, Type 4, stainless steel anchors with 3 1/2-inch minimum embedment bolt length.
- C. Beam C-Clamps:
  - 1. Beam clamps: Use where piping is suspended from building steel.
  - 2. Select clamp based on load supported and load configuration.
  - 3. C-Clamps: provide locknuts and cup point set screws.
  - 4. Top flange C-Clamps: Use when attaching hanger rod to top flange of structural shapes.
- D. Hanger rods: Threaded on both ends or continuously threaded rods of circular cross section. No wire, chain, or perforated straps allowed.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Protection: Properly cap open ends of pipe at end of each day's work or other stopping point throughout construction. Tightly cover equipment and protect against dirt, water, chemical, and mechanical damage.

### **3.02 INSTALLATION**

- A. Install in accordance with New Mexico Plumbing Code.
- B. Install drains in accordance with manufacturer's instructions and recommendations.
- C. Install trench drains at low points of surface areas to be drained, as indicated on drawings. Set grates of drains flush with finished surface, unless otherwise indicated:
  - 1. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- D. Drainage piping in chases: Pitch uniformly at 1/4-inch per foot grade, unless otherwise shown on drawings.

### **3.03 CONTRACTOR FIELD QUALITY TESTING**

- A. Notify COR in writing at least 14 working days prior to flushing and testing. Include the following:
  - 1. Copy of approved Test Plan.
  - 2. Date and time system shall be ready for testing.
  - 3. Period required to complete testing.

- B. All tests including flushing shall be witnessed by COR.
- C. Flush pipe thoroughly until discharge is clear and free of all debris:
  - 1. Do not utilize sump pumps during test.
  - 2. Clean each sump and daylight to COR approved termination points at conclusion of testing.
- D. Test piping in accordance with New Mexico Plumbing Code:
  - 1. Test gravity drainage piping system with minimum of 10-feet of water or 5-lbs/in<sup>2</sup> of air.
  - 2. Conduct pressure test for period of at least 15-minutes to verify system is tight with no leakage or reduction in pressure.
- E. Repair and retest if required.
- F. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- G. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION**

**SECTION 22 14 30**  
**SUMP PUMPING SYSTEMS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Sump Pumping Systems:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American Society of Mechanical Engineers (ASME)

1. ASME B16.18-2012 Cast Copper Alloy Solder Joint Pressure Fittings
2. ASME B16.22-2013 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
3. ASME B31.9-2017 Power Piping and Process Piping

B. ASTM International (ASTM)

1. ASTM A32/A312M-17 Seamless, Welded, and Heavily Cold Worked Austenitic Stainless-Steel Pipes
2. ASTM A182/A182M-18 Forged or Rolled Alloy and Stainless-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
3. ASTM A351/A351M-18 Castings, Austenitic, for Pressure-Containing Parts

C. Commercial Item Description (CID)

1. CID A-A-1923A-1995 Shield Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors

D. Cast Iron Soil Pipe Institute (CISPI)

1. CISPI 310-2012 Couplings for Use in Connection with Hubless Cast Iron Sanitary and Storm Drain, Waste and Vent Piping Applications

E. Manufacturers Standardization Society (MSS)

1. MSS SP-58-2009 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application and Installation
2. MSS SP-80-2014 Bronze Gate, Globe, Angle and Check Valves

- F. National Electrical Manufacturers Association (NEMA)
  - 1. NEMA 250 – 2014 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- G. New Mexico Plumbing Code 2012

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.

- B. RSN 22 14 30-1, Approval Data:

- 1. Commercial product data including catalog illustrations, sizes, material, pressure ratings, manufacturer's installation instructions and complete parts lists for the following:
  - a. Sump Pumps:
    - 1) Commercial product data include pump curve.
    - 2) Electrical schematics and wiring diagrams.
  - b. Piping and appurtenances.
  - c. Sump pump rail mounting system.
  - d. Sump pump controllers.
  - e. Pipe hangers and supports.
  - f. Float or pressure switches.
  - g. Controls and alarms.
  - h. Accessories.
  - i. Schematic and wiring diagrams.
- 2. Drawings at 1/4-inch per foot scale showing materials and dimensions of complete sump pumping system, in Plan and Section views.

- C. RSN 22 14 30-2, Test Plan:

- 1. Include step by step instructions, time estimates, and list of required equipment.

- D. RSN 22 14 30-3, Final Drawings and Data:

- 1. Operation and Maintenance Manuals, in booklet form:
  - a. Submit complete installation, operation and maintenance manuals, including:
    - 1) Maintenance data and schedules.
    - 2) Description of operation and spare parts information.
    - 3) All previously approved data submitted under RSN 22 14 30-1.
    - 4) Half size (11- by 17-inch) as built drawings.
    - 5) Any applicable test records or reports.

2. Test results.
3. As-built Drawings:
  - a. Provide full size drawings in Government Format, see requirements in section 01 33 00 – Submittals.
  - b. Provide CDs in AutoCAD format.

#### **1.04 SYSTEM DESCRIPTION**

- A. Sump pump discharges water collected in plant gravity drainage system (described in Section 22 13 16 – Plant Gravity Drainage Piping Systems), to a pipeline that discharges into drainage ditch described in Section 33 11 16 – Site Water Utility Piping. Sump pump requires use of rail system and prefabricated basin. Sump basin will be vented through a combination of embedded and exposed cast iron pipe.
- B. Performance Requirements:
  1. Install sump pump systems, piping and accessories to create complete functional system in the following locations as shown on drawings:
    - a. Main Plant Sump.
    - b. Chemical Building Safety Shower (Pumping Plant No. 4 only).
    - c. Turnout Building Sump.
  2. Gravity drainage piping to main plant sump to be in accordance with 22 13 16 – Plant Gravity Drainage Piping Systems.
  3. Sump discharge piping to be in accordance with this specification for the following.
    - a. Main Plant Sump pump discharge piping located within building foot print.
    - b. Chemical Building Safety Shower Sump pump discharge piping within the building foot print.
    - c. Turnout Building sump discharge piping within building foot print.
  4. Buried yard piping installation and product data to be in accordance with 33 11 16 – Site Water Utility Piping:
    - a. Piping of main plant sump discharge from building foundation to discharge location.
    - b. Piping of Chemical Building safety shower sump discharge from building foundation to discharge location.
    - c. Piping of Turnout Building sump discharge from building foundation to discharge location.

5. Pumps will require level control systems to energize sump pumps at predetermined water levels as shown on drawing. Levels to be controlled with level floats as shown on drawing. Level control system will de-energize drainage sump pump when water level is lowered to predetermined low water level as shown on drawing.
6. Sump pumps will utilize hardwired level control arrangement.
7. High level alarm and each sump will provide local audio alert if predetermined high water level is exceeded. Signal will also be sent to SCADA system.
8. Oil level detection alarm to be provided in main plant sump located in air chamber room. Oil detection alarm will provide local audio alert if oil is detected in sump liquid. Signal will also be sent to SCADA system.

## **PART 2 PRODUCTS**

### **2.01 SUMP PUMPING UNITS**

#### **A. Main Plant Duplex Sump Pump System:**

1. Submersible Sump pumps, having the following essential characteristics:
  - a. Rated condition: Minimum flow of no less than 38 gallons per minute (gpm) at 22-feet total dynamic head.
  - b. Power rating of 1 hp or less.
  - c. Constructed of watertight cast iron corrosion resistant materials with stainless steel fasteners.
  - d. Internal check valve not allowed.
  - e. Pump and motor assembled as an integral unit.
  - f. Furnish non-clog type impeller suitable for passing solids up to 1/2-inch diameter.
  - g. Furnish with integral debris strainer.
  - h. Furnish a 208V, 3-phase, 60-hertz, motor with thermal overload protection and automatic reset.
  - i. Furnish at minimum 20-foot oil and water-resistant power cord for connection to control box.
  - j. Furnish automatic float switch operation utilizing 4 separate floats for first pump on, second pump on, all pumps off and high alarm.
  - k. Furnish oil level detector.
  - l. Furnish NEMA 4X junction box inside the basin.

2. Sump Pump Basin:
  - a. High density polyethylene structural foam (PSF), polyethylene or Fiberglass Reinforced polyester (FRP) construction.
  - b. Basin dimensions as shown on drawing.
  - c. Inlet, vent, and discharge locations and sizes as shown on drawing.
  - d. Steel or aluminum hatch cover hinged and lockable with gas tight seal.
  - e. Lockable hatch opening with locking lift mechanism.
3. Sump Rail System:
  - a. Stainless steel guide rail, supports, pump adapter flange, and plates.
  - b. Stainless steel retrieval cable.
4. Sump Electrical Control Panel:
  - a. Duplex pump controller for parallel pump operations:
    - 1) Lead/lag alternating pump operation.
  - b. 208V.
  - c. Complete with three (4) 20-foot minimum length control float switches.
  - d. Motor contactor.
  - e. NEMA 12 enclosure with lockable latch.
  - f. Top-mounted alarm light.
  - g. Alarm horn provides audio warning of alarm condition (85 decibel max rating):
    - 1) High Level.
    - 2) Oil Detection.
  - h. Pump run indicator light for each pump.
  - i. Horn silence and alarm test toggle switches.
  - j. Local Hand-Off-Auto (HOA) switch.
  - k. Lockable latch.
  - l. Dry auxiliary contact for SCADA interconnect of:
    - 1) High level.
    - 2) Oil Detection.
  - m. UL Listed.
  - n. Provide NEMA 12 wall mount disconnect switch.
  - o. Alarm events shall not interfere with system operations.

B. Turnout Building Simplex Sump Pump System:

1. Submersible sump pump, having the following essential characteristics:
  - a. Rated condition: Minimum flow of no less than 25-gallons per minute (gpm) at 10-foot total dynamic head.
  - b. Power rating of 1/2 hp or less.
  - c. Constructed of watertight cast iron corrosion resistant materials with stainless steel fasteners.
  - d. Internal check valve not allowed.
  - e. Pump and motor assembled as an integral unit.
  - f. Furnish non-clog type impeller suitable for passing solids up to 1/2-inch diameter.
  - g. Furnish with integral debris strainer.
  - h. Furnish a 230V, 1-phase, 60-hertz, motor with thermal overload protection and automatic reset.
  - i. Furnish a 20-foot minimum length oil and water-resistant power cord for connection to NEMA 4X control box inside basin.
  - j. Furnish automatic float switch operation utilizing 3 separate floats for pump on, pump off and high alarm.
2. Sump pump basin:
  - a. High density polyethylene structural foam (PSF), polyethylene or Fiberglass Reinforced polyester (FRP) construction.
  - b. Basin dimensions as shown on drawing.
3. Sump cover
  - a. Material: Aluminum or Steel.
  - b. Minimum load rating of 300 psf.
  - c. Slip resistant walking surface.
  - d. Perforated for drainage, with maximum hole diameter of 1/2-inch.
  - e. Bolt down.
  - f. Electrical cord grommet.
  - g. 1 1/2-inch discharge flange.
4. Sump electrical control panel:
  - a. Simplex pump controller.
  - b. 240V.
  - c. Complete with three (3) 20-foot minimum length control float switches.
  - d. Motor contactor.

- e. NEMA 12 watertight enclosure with lockable latch.
- f. Alarm horn provides audio warning of alarm condition (85 decibel max rating).
- g. Pump run indicator light.
- h. Horn silence and alarm test toggle switches.
- i. Local Hand-Off-Auto (HOA) switch.
- j. Lockable latch.
- k. Dry auxiliary contact for SCADA interconnect.
- l. UL Listed.
- m. Provide NEMA 12 wall mount disconnect switch.
- n. Alarm events shall not interfere with system operations.

C. Safety Shower Simplex Sump Pump System:

1. Submersible sump pump, having the following essential characteristics:
  - a. Rated condition: Minimum flow of no less than 25 gallons per minute (gpm) at 10-feet total dynamic head.
  - b. Power rating of 1/2 hp or less.
  - c. Constructed of watertight cast iron corrosion resistant materials with stainless steel fasteners.
  - d. Internal check valve not allowed.
  - e. Pump and motor assembled as an integral unit.
  - f. Furnish non-clog type impeller suitable for passing solids up to 1/2-inch diameter.
  - g. Furnish with integral debris strainer.
  - h. Furnish a 230V, 1-phase, 60-hertz, motor with thermal overload protection and automatic reset.
  - i. Furnish 20-foot minimum length oil and water resistant power cord for connection to NEMA 4X control box on wall in Chemical Building.
  - j. Furnish automatic float switch operation utilizing 3 separate floats for pump on, pump off and high alarm.
2. Sump pump basin:
  - a. High density polyethylene structural foam (PSF), polyethylene or Fiberglass Reinforced polyester (FRP) construction.
  - b. Basin dimensions as shown on drawing.
  - c. Inlet, discharge and conduit locations and sizes as shown on drawing.

3. Sump cover:
  - a. Material: Aluminum or Steel.
  - b. Minimum load rating of 300 psf.
  - c. Slip resistant walking surface.
  - d. Perforated for safety shower drainage, with maximum hole diameter of 1/2-inch.
  - e. Bolt down.
4. Sump electrical control panel:
  - a. Simplex Controller.
  - b. 240V.
  - c. Complete with three (3) 20-foot minimum length control float switches.
  - d. Motor contactor.
  - e. NEMA 4X watertight enclosure with lockable latch.
  - f. Top-mounted alarm light.
  - g. Alarm horn provides audio warning of alarm condition (85 decibel max rating).
  - h. Pump run indicator light.
  - i. Horn silence and alarm test toggle switches.
  - j. Local Hand-Off-Auto (HOA) switch.
  - k. Lockable latch.
  - l. Dry auxiliary contact for SCADA interconnect.
  - m. UL Listed.
  - n. Provide NEMA 4X wall mount disconnect switch.

## 2.02 ALARMS

- A. High Level Alarm (Main Plant Sump, Chemical Building Safety Shower Sump and Turnout Building Sumps):
  1. When high level is reached, float level switch will send signal and alarm shall notify operator through SCADA system and local alarm indicator (alarm only, no controls).
  2. 120V AC.
  3. Mercury free.
  4. Adjustable high-water level.
  5. NEMA 4X enclosure.

- B. Oil Indicator Alarm (Main Plant Sump Only):
1. If oil is detected, alarm shall notify operator through SCADA system and local alarm indicator (alarm only, no controls).
  2. 120V AC.
  3. Mercury free.
  4. NEMA 4X enclosure.

### **2.03 PIPING AND APPURTENANCES**

- A. Piping and Fittings:
1. Pipe: ASTM A312 304/304L Stainless Steel.
  2. Pipe Fittings and Unions: ASME B16.11 or ASME B16.3 threaded pipe fittings, ASTM A182 or A351 304 Stainless Steel.
  3. Reducers: Concentric type, stainless steel construction. No bushings are permitted.
- B. Swing Check Valve:
1. Valve design MSS SP-80.
  2. Cast iron or bronze body.
  3. Vertical or horizontal installation.
  4. Full flow design.
  5. Stainless steel hardware.
- C. Automatic Drain Valve:
1. Auto-Drain Valve Model 70 Part 4501SSX manufactured by Flomatic, 15 Pruyn's Island Drive, Glens Falls, NY 12801, 1-800-833-2040; or equal, having the following essential characteristics:
    - a. Valve Closing pressure: 5 psi
    - b. Normally open
    - c. Connection: 1-inch NPT Male Connection
    - d. Material:
      - 1) Stainless Steel: Body, spring, fasteners, and valve disc
      - 2) Acetyl: Valve Follower guide.

### **2.04 PIPE HANGERS AND SUPPORTS**

- A. Pipe Hangers and Supports for Copper Tube: Carbon steel with copper-plated components in accordance with ASME B31.9, MSS SP-58, and New Mexico Plumbing Codes.

- B. Pipe Hangers and Supports for Exposed Vent Piping:
1. Galvanized zinc plated carbon steel or malleable iron in accordance with MSS SP-58.
  2. Beam C-Clamps:
    - a. Use where piping is suspended from building steel.
    - b. Select clamp on basis of load supported and load configuration.
    - c. C-Clamps: Provide locknuts and cup point set screws.
    - d. Top flange C-Clamps: Use when attaching hanger rod to top flange of structural shapes.
  3. Hanger rods: Threaded on both ends or continuously threaded rods of circular cross section. No wire, chain, or perforated straps allowed.
- C. Expansion Anchors:
1. Expansion anchors in accordance with CID A-A-1923A, Type 4, stainless steel anchors with 3 1/2-inch minimum embedment bolt length.

## **2.05 ACCESSORIES**

- A. Wall Seal having the following essential characteristics:
1. Modular, water tight, mechanical seal, consisting of interlocking, synthetic rubber links shaped to continuously fill annular space between pipe and wall opening.
  2. Stainless steel hardware.
- B. Sleeves:
1. Form sleeves for pipes through non-fire rated walls and floor slabs with steel pipe or No. 18 United States Standard Steel gauge galvanized steel.
  2. Provide sleeves at least two sizes larger than sump pump discharge pipe.
- C. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials:
1. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig minimum working pressure at 180 degrees F. Include insulating material that isolates dissimilar metals and ends with inside threads.
  2. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure to suit system pressures.
  3. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 degrees F.

## 2.06 COATINGS

- A. Paint pipe in accordance with Section 09 96 20 – Coatings.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. General:
  - 1. Provide dielectric connections wherever joining dissimilar metals. Locate unions in accessible places.
  - 2. Make changes in direction with pipe fittings.
  - 3. Protection:
    - a. Plug or cap open ends of pipe at end of each work day or other stopping point throughout construction.
    - b. Tightly cover equipment and protected against dirt, water, chemical, or mechanical damage.
- B. Install pumping units and appurtenances as shown on drawings.
- C. Install accordance with New Mexico Plumbing Codes.
- D. Install intake of sump pumping unit level with sump basin floor.
- E. Provide necessary pipe fittings to connect pumping unit discharge outlet to discharge piping without putting stress on discharge outlet.
- F. Install in accordance with ASME B31.9.
- G. Make connections through sump basin using commercially available fittings. No rough-cut fittings allowed.
- H. Seal all mounting screws below water high water level using silicone.
- I. Provide power from wall mount NEMA 12X wall mount disconnect switch to NEMA 4X control box located inside sump basin (air chamber room only).
- J. Stainless Steel Piping:
  - 1. Buried joint: Socket welded.
  - 2. Exposed Joints: Threaded or Flanged.
  - 3. Bushings not permitted. Make changes in pipe sizes with fittings.
  - 4. Provide dielectric connections wherever joining dissimilar metals, and locate in accessible places.
  - 5. Install unions as shown on drawings.

- K. Pipe Hangers and Supports:
1. Install pipe hangers and supports in accordance with ASME B31.9 and MSS SP-58. Arrange piping supports so no excessive bending stresses are induced into piping from concentrated loads between supports.
  2. Provide additional hangers and supports wherever concentrated loads from valves or heavy fittings occur, or at changes in direction of piping.
- L. Provide sleeves for pipes passing through partitions, walls and floors.
- M. Wall Seal:
1. Install wall seals in annular space between discharge pipe and wall sleeve opening.
  2. Uniformly tighten wall seals in circular pattern or as directed by manufacturer's installation instructions.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. General:
1. Notify COR in writing at least 14 working days prior to testing. Include the following:
    - a. Copy of approved testing plan.
    - b. Date and time system shall be ready for testing.
    - c. Period required to complete testing.
  2. Tests shall be witnessed by COR.
  3. After specification Section 26 05 90 – Wiring Checkout and Tests is complete, test new operation of sump pumps, level switches, controls, alarms, and piping after installation. Fill sump with water to verify operation of probes.
  4. Furnish materials, supplies, labor, and equipment required for tests including potable water, temporary flanges and plugs required for tests.
  5. Inspect, test and repair work to be concealed and covered prior to concealing or covering:
    - a. Operate unit continuously at rated head and discharge for a period of not less than 30-minutes.
    - b. Observe pumping unit to detect any excessive vibration, noise or heating.
    - c. Hydrostatic test sump pumping system piping with water in accordance with ASME B31.9 for a 1-hour period with no leakage or reduction in pressure. If leaks develop, repair and retest for an additional 1-hour period until all leaks have been eliminated
  6. Make repairs in a manner approved by COR. Retest after repairs.

**END OF SECTION**

**SECTION 22 45 00**  
**EMERGENCY PLUMBING FIXTURES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Emergency Plumbing Fixtures:
1. Payment: Lump sum price offered in Price Schedule 1 (Pumping Plant No. 4).

**1.02 REFERENCE STANDARDS**

- A. American National Standards Institute (ANSI)
1. ANSI Z358.1 - 2014                      Emergency Eyewash and Shower Equipment
- B. American Society of Mechanical Engineers (ASME)
1. ASME B16.5-2017                      Pipe Flanges and Flanged Fittings
  2. ASME BPVC VIII-2017              ASME Boiler & Pressure Vessel Code-  
Section VIII- Pressure Vessels
- C. National Electric Manufacturers Association (NEMA)
- NEMA 250-2014                      Enclosures for Electrical Equipment

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals:
- B. RSN 22 45 00-1, Approval Data and Drawings:
1. Commercial product data including catalog illustrations, sizes, rough-in dimensions, trim finishes, and complete parts lists for items listed under Products.
- C. RSN 22 45 00-2, Test Plan:
1. Include step by step instructions, time estimates, and list of required equipment.
- D. RSN 22 45 00-3, Final Data and Drawings:
1. Data submitted and approved under RSN 22 45 00-1.
  2. Test results.
  3. Operation and Maintenance Manuals:
    - a. Complete installation, operation and maintenance manuals, including maintenance data and schedules, description of operation and spare parts information for products submitted under RSN 22 45 00-1.

## **PART 2 PRODUCTS**

### **2.01 SAFETY EQUIPMENT**

- A. Drench Shower with Eye/Facewash:
1. Integral surface mount catch pan located immediately below eye/facewash.
  2. Stainless steel showerhead and eyewash receptor.
  3. Instant action, stay open chrome-plated brass ball valve activated by rigid stainless steel pull rod and foot treadle.
  4. 1 1/4-inch galvanized steel water pipe with floor flange support.
  5. High visibility paint scheme with universal emergency sign.
  6. Eyewash heads with dust covers.
  7. Stream control with pressure compensated devices.
  8. ANSI Z358.1 compliant.

### **2.02 WATER HEATERS**

- A. Model A9108480 EFD N4X SafeAdvantage Tankless Water Heater manufactured by EEmax, 353 Christian Street, Oxford, CT 06478 or equivalent, having the following essential characteristics:
1. Capable of supplying 23 gpm with 32 degree F rise
  2. Commercial electric, tankless type with thermostatically controlled adjustable output temperature.
  3. Replaceable nickel chrome cartridge insert heating element.
  4. Minimum 3-year warranty.
  5. Micro-processing temperature control providing temperature accuracy of  $\pm 1$  degree F.
  6. Flow switch activated with first stage for eyewash and second stage for drench shower.
  7. 480V, 108 kW.
  8. NEMA 4X.

### **2.03 BOOSTER PUMP**

- A. Model CRI 5- 4 manufactured by Grundfos, 2001 Butterfield Road, Suite 1700, Downers Grove, IL 60515, or equivalent, having the following essential characteristics:
1. Capable of supplying 23 gpm at 30 pounds per square inch (psi).
  2. 480V, 3 phase, 60 Hz.
  3. Flanges Class 150 per ASME B16.5.

4. Materials:
  - a. Cast iron pump head.
  - b. Stainless steel wetted components.
  - c. EPDM for rubber components.
5. Net Positive Suction Head (NPSH<sub>A</sub>): 10-psi.
6. Pump shall be activated via a pressure switch located at the shower. See drawings for details.
7. Motors: Totally Enclosed Fan-Cooled (TEFC), NEMA 4X enclosure.

#### **2.04 HYDROPNEUMATIC TANK**

- A. Model FXA-400 manufactured by Wessels Company, 101 Tank St., Greenwood, IN 46143, or equivalent, having the following essential characteristics:
  1. Drawdown capacity of 45-gallons.
  2. Replaceable bladder.
  3. Fabricated to requirements of ASME BPVC Section VIII.
  4. Pressure of 125-psi.

#### **2.05 PIPE, VALVES AND ACCESSORIES**

- A. All pipe, valves and accessories are to be in accordance with Section 22 11 10 – Plant Auxiliary Water Systems.

### **PART 3 EXECUTION**

#### **3.01 PROTECTION**

- A. Properly plug or cap the open ends of pipe at the end of each work day or other stopping point throughout construction. Equipment shall be tightly covered and protected against dirt, water, chemical or mechanical damage.

#### **3.02 INSTALLATION**

- A. General:
  1. Install all tank and pump per standard drawing 40-D-5599
  2. Make all electrical connections in accordance with Division 26 – Electrical
- B. Water Heaters:
  1. Install in accordance with manufacturer's recommendations.
  2. Provide isolation ball valves within 3-feet of inlet and outlet.

3. Provide unions between isolation ball valves and water heater.

C. Safety Shower:

1. Install in accordance with manufacturer's recommendations and ANSI Z358.1.
2. Disinfect in accordance with Section 22 11 10 – Plant Auxiliary Water Systems.
3. Place caps over eyewash.
4. Hang signs or labels provided by manufacturer.

### **3.03 CONTRACTOR FIELD QUALITY TESTING**

A. General:

1. Notify COR in writing at least 14 working days prior to testing. Include the following:
  - a. Copy of approved test plan.
  - b. Date and time system shall be ready for testing.
  - c. Period of time required to complete testing.
2. All tests shall be witnessed by COR.
3. Test new piping systems after installation:
  - a. Furnish materials, supplies, labor, and equipment required for tests including temporary flanges and plugs required for tests.
  - b. Disconnect or isolate instruments and equipment that are not designed for test pressures prior to testing piping and reconnect after testing.
  - c. Inspect, test and repair work to be concealed and covered prior to concealing or covering.

B. Subject systems to operating tests to demonstrate function and operation to satisfaction of COR by operating each device.

C. Drench shower with eye/face wash:

1. Test flow and temperature according to ANSI Z358.1 and make any required adjustments. Upon completion of adjustments demonstrate compliance to COR.
2. Ensure pump starts and stops at the required pressures shown on drawings via pressure switch operation.

**END OF SECTION**

**SECTION 23 00 00**  
**HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Heating, Ventilating, and Air-Conditioning (HVAC) System:
1. Payment: Lump sum price offered in the Price Schedules:
    - a. Includes Heating, Ventilating, and Air-Conditioning (HVAC) system shown on drawings 1695-D-60493 through 1695-D-60500.
    - b. Prices include cost of providing HVAC equipment and control system(s) as shown on drawings and in accordance with Division 23 – Heating, Ventilating and Air-Conditioning.

**1.02 SYSTEM DESCRIPTION**

- A. Pumping Plant No. 4 consists of the following buildings:
1. Pumping Plant and Air Chamber.
  2. Chemical Building.
  3. Utility Vault.
  4. Turn out Building.
- B. Pumping Plant No. 7 consists of the following buildings:
1. Pumping Plant and Air Chamber
  2. Turn out Building.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 23 00 00 – 1, Approval Drawings
1. Drawings showing the complete system and duct layout in Plan and Section views.
  2. Schedules indicating approved equipment.
- C. RSN 23 00 00 – 2, Final Drawings
1. As-Built drawings.
    - a. Provide drawings in Government Format in .pdf and AutoCAD format.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 23 05 13**  
**COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in Lump Sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. American Bearing Manufacturers Association (ABMA)

1. ABMA 9-2015 Load Ratings and Fatigue Life for Ball Bearings

B. National Electrical Manufacturers Association (NEMA)

1. NEMA MG 1-2016 Motors and Generators

**1.03 SUBMITTALS**

- A. Provide motor product data with RSN that is specific to equipment it is serving, including nameplate data, efficiency, electrical ratings and quality testing documentation.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- B. Protect products from weather and moisture by covering with plastic or canvas.
- C. For extended outdoor storage, remove motors from equipment and store separately.

**PART 2 PRODUCTS**

**2.01 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT**

- A. Poly-Phase Motors: NEMA MG 1, Design B, premium efficiency motor, with windings to accomplish starting methods, voltage and number of speeds as indicated on drawings:
1. Service Factor: 1.15.
  2. Enclosure: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

3. Designed for continuous operation in 40 degree C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
  4. Insulation System: NEMA Class F.
  5. Bearings: Anti-friction ball bearings, rated for minimum ABMA 9, L-10 life of 200,000-hours. Calculate bearing load with NEMA minimum load. Stamp bearing sizes on nameplate.
  6. Sound Power Levels: Conform to NEMA MG 1.
- B. Single Phase Motors:
1. Permanent split-capacitor type, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
  2. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading rated for minimum ABMA 9, L-10 life of 200,000 hours.
  3. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- C. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials as necessary.

### **PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 23 05 29**  
**SUPPORTS FOR HVAC DUCT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. ASTM International:

1. ASTM A36/A36M-2019 Carbon Structural Steel

B. American Society of Civil Engineers (ASCE)

1. ASCE 7-2016 Minimum Design Loads and Associated Criteria for Buildings and Other Structures

C. American Welding Society (AWS):

1. AWS D1.1-2015 Structural Welding Code

D. Metal Framing Manufacturers Association (MFMA):

1. MFMA 4-2004 Metal Framing Standard

E. Sheet Metal and Air Conditioning Contracting National Association (SMACNA)

1. Seismic Restraint Manual Guidelines for Mechanical Systems
2. SMACNA 1966-2006 HVAC Duct Construction Standards

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 23 05 29-1, Approval Data:

1. Product data: Provide manufacturer's catalog data for all duct supports.
2. Shop Drawings for exterior ducts: Show fabrication and installation details and include calculations for all exterior duct supports.

**1.04 PERFORMANCE REQUIREMENTS**

A. Exterior duct:

1. Design, furnish and install duct supports and stands as required by this specification and SMACNA 1966.

2. Structural Performance: Supports for exterior HVAC duct to withstand effects of gravity loads and stresses within limits and under conditions indicated according to SMACNA Seismic Restraint Manual and ASCE 7:
  - a. Design supports, including stands, capable of supporting combined weight of duct and connected systems and components.
- B. Interior duct: Furnish and install duct supports and/or hangers as required by this specification and SMACNA 1966.

## **1.05 QUALITY ASSURANCE**

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1.

## **PART 2 PRODUCTS**

### **2.01 DUCT SUPPORTS**

- A. General Requirements: Welded, shop- or field-fabricated duct support made from structural carbon-steel shapes to support exterior grade-supported ductwork.
- B. Stands:
  1. High-Type, Duct Stand:
    - a. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for on-grade installation.
    - b. Bases: recycled rubber with load distribution plate under grouted base.
    - c. Vertical Members: Two or more protective-coated-steel channels.
    - d. Horizontal Member: Protective-coated-steel channel.
- C. Metal Framing Systems:
  1. Description: Shop- or field-fabricated duct-support assembly for supporting exterior ductwork.
  2. Standard: MFMA-4.
  3. Channels: Continuous slotted steel channel with in-turned lips.
  4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  5. Metallic Coating: Electroplated zinc or hot-dipped galvanized.
- D. Miscellaneous Materials:
  1. Structural Steel: ASTM A36, carbon-steel plates, shapes, and bars; black and galvanized.
- E. Grout shall be in accordance with 03 63 00 – Epoxy Grout.

## **2.02 HANGERS**

- A. Zinc-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA 1966.
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Galvanized-steel shapes and plates.

## **PART 3 EXECUTION**

### **3.01 SUPPORT INSTALLATION**

- A. Install supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- B. Fabricate from welded-structural-steel shapes. Weld steel according to AWS D1.1.
- C. Install hangers and supports to allow controlled thermal and seismic movement of duct systems, to permit freedom of movement between anchors.
- D. Supports to be connected to ducts with steel angles or channel secured to sides of duct with welds, bolts, sheet metal screws, or blind rivets.
- E. Install building attachments within concrete slabs or attach to structural steel.
- F. Support system without sagging, including supports at each offset or change in direction and at ends of duct branches over 5-feet in length.
- G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Grouting: Place grout under supports for equipment and make bearing surface smooth.

### **3.02 METAL FABRICATIONS**

- A. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

- B. Field Welding: Comply with AWS D1.1 procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

**END OF SECTION**

**SECTION 23 05 53**  
**IDENTIFICATION – HVAC**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. American Society of Mechanical Engineers (ASME)

1. ASME A13.1-2015 Scheme for the Identification of Piping Systems

**1.03 EXTRA MATERIALS**

- A. Spare Parts and Maintenance Products: Supply two containers of spray-on adhesive.

**PART 2 PRODUCTS**

**2.01 HVAC EQUIPMENT NAMEPLATES**

A. Plastic Nameplates:

1. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
2. Provide in accordance with Standard Drawing 40-D-6234.
3. Provide for the following:
  - a. Rooftop units.
  - b. Packaged Terminal Air Conditioner Units.
  - c. Fans.
  - d. Unit Heaters.

**2.02 CONTROL EQUIPMENT NAMEPLATES**

A. Plastic Nameplates:

1. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
2. Provide in accordance with Standard Drawing 40-D-6234.
3. Provide for all HVAC control panels.

**2.03 DUCT MARKERS**

- A. Color and Lettering: Conform to ASME A13.1.
- B. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

**PART 3 EXECUTION****3.01 PREPARATION**

- A. Degrease and clean surfaces to receive adhesive for identification materials.

**3.02 INSTALLATION**

- A. Install identifying devices after completion of coverings and painting.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or a combination of mechanical fasteners and adhesive.
- C. Identify service and flow direction. Install in clear view and align with axis of piping.
- D. Locate identification not to exceed 20-feet on centers on straight runs of piping and ductwork including risers and drops, adjacent to each damper, tee, at each side of penetration of structure or enclosure, and at each obstruction.

**END OF SECTION**

**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum price offered in Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. Associated Air Balance Council (AABC)

1. AABC-2016 National Standards for Total System Balance.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 111-2008 (RA 2017) Testing, Adjusting and Balancing of Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau (NEBB 2005)

1. NEBB -2018 Testing, Adjusting, and Balancing of Environmental Systems.

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 23 05 93-1 Final Data:

1. Certified Testing Adjusting and Balance Reports that include the following:
  - a. Qualification Certification that indicates compliance with the requirements of this specification section.
  - b. Test Reports: Indicate data on one of the following:
    - 1) AABC National Standards for Total System Balance forms.
    - 2) Forms prepared following ASHRAE 111.
    - 3) NEBB Report forms.
2. Furnish reports in hard cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings and schematics with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

## **1.04 QUALITY ASSURANCE**

- A. Perform Work in accordance with one of the following:
  - 1. AABC.
  - 2. Total System Balance ASHRAE 111.
  - 3. NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Maintain one copy of selected document on site.
- C. Prior to commencing work, calibrate each instrument to be used.

## **1.05 QUALIFICATIONS**

- A. Perform Work under supervision of one of the following:
  - 1. AABC Certified Test and Balance Engineer.
  - 2. NEBB Certified Testing, Balancing and Adjusting Supervisor.
  - 3. Registered Professional Engineer in State of New Mexico experienced in performance of this work.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify systems are complete and operable before commencing work. Verify the following:
  - 1. Systems are started and operating in safe and normal condition.
  - 2. HVAC control systems are installed complete and operable.
  - 3. Proper thermal overload protection is in place for electrical equipment.
  - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - 5. Duct systems are clean and free of debris.
  - 6. Fans are rotating correctly.
  - 7. Dampers are in place and in normal position.
  - 8. Air coil fins are cleaned and combed.
  - 9. Access doors are closed, and duct end caps are in place.

10. Air outlets are installed and connected.
11. Duct system leakage is minimized.

### **3.02 PREPARATION**

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to COR to facilitate spot checks during testing.

### **3.03 INSTALLATION TOLERANCES**

- A. Air Outlets and Inlets: Adjust to within plus 10 percent or minus 5 percent of design to space.

### **3.04 ADJUSTING**

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of dampers and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Report defects and deficiencies noted during performance of services, preventing system balance.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by COR.

### **3.05 GENERAL AIR SYSTEM PROCEDURE**

- A. Make air flow rate measurements in main ducts by Pitot tube traverse of entire cross-sectional area of duct.
- B. Measure air quantities at air inlets and outlets.
- C. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- D. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- E. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

- F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- G. Adjust outside air automatic dampers, outside air, and exhaust dampers for design conditions.
- H. Measure temperature conditions across outside air and exhaust dampers to check leakage.
- I. Building Pressure Testing, Adjusting, Balancing:
  - 1. Pumping Plants and Air Chamber: Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05-inches differential static pressure between spaces.
  - 2. Chemical Building: Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately a 0.05-inches negative static pressure within building relative to outdoors.

### **3.06 PROCEDURES FOR AIR SYSTEMS**

- A. Adjust fans to deliver total indicated airflows within maximum allowable fan speed listed by fan manufacturer:
  - 1. Measure total airflow:
    - a. Where sufficient space in ducts is unavailable for Pitot tube traverse measurements, measure airflow at terminal outlets and inlets, and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at fan outlet or through flexible connection.
    - c. Measure inlet static pressure of fans in inlet duct as near fan as possible, upstream from flexible connection, and downstream from duct restrictions.
  - 3. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions:
    - a. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors.
    - b. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine maximum required brake horsepower.

### **3.07 PROCEDURES FOR MOTORS**

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number:
    - a. Motor horsepower rating.
    - b. Motor Revolutions per Minute (rpm).
    - c. Efficiency rating.
    - d. Nameplate and measured voltage, each phase.
    - e. Nameplate and measured amperage, each phase.
    - f. Starter thermal-protection-element rating.

### **3.08 PROCEDURES FOR PACKAGED TERMINAL AIR CONDITIONERS**

- A. Measure, adjust, and record the following data:
1. Nameplate data.
  2. Airflow.
  3. Entering- and leaving-air temperature at full load.
  4. Voltage and amperage input of each phase at full load and at each incremental stage.
  5. Calculated kilowatt at full load.
  6. Fuse or circuit-breaker rating for overload protection.

### **3.09 PROCEDURES FOR ROOFTOP UNITS**

- A. Measure, adjust, and record the following data:
1. Adjust fans to deliver total indicated airflows within maximum allowable fan speed listed by fan manufacturer:
    - a. Measure total airflow.
      - 1) Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate total airflow.
    - b. Measure fan static pressures as follows to determine actual static pressure:
      - 1) Measure outlet static pressure as far downstream from fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      - 2) Measure static pressure directly at fan outlet or through flexible connection.

- 3) Measure inlet static pressure of single-inlet fans in inlet duct as near fan as possible, upstream from flexible connection, and downstream from duct restrictions.
    - 4) Measure inlet static pressure of double-inlet fans through wall of plenum that houses fan.
  - c. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment:
    - 1) Report cleanliness status of filters and time static pressures are measured.
  - d. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
2. Procedures for condensing units:
  - a. Verify proper rotation of fans.
  - b. Measure entering- and leaving-air temperatures.
  - c. Record compressor data.
3. Measure, adjust, and record the following data for each electric heating coil:
  - a. Nameplate data.
  - b. Airflow.
  - c. Entering- and leaving-air temperature at full load.
  - d. Voltage and amperage input of each phase at full load and at each incremental stage.
  - e. Calculated kilowatt at full load.
  - f. Fuse or circuit-breaker rating for overload protection.
4. Measure, adjust, and record the following data for each refrigerant coil:
  - a. Dry-bulb temperature of entering and leaving air.
  - b. Wet-bulb temperature of entering and leaving air.
  - c. Airflow.
  - d. Air pressure drop.
  - e. Refrigerant suction pressure and temperature as obtained from mechanical contractor.

### 3.10 SCHEDULES

- A. List of Equipment Requiring Testing, Adjusting, and Balancing:
  1. Ventilation fans.

2. Rooftop units.
3. Air inlets and outlets.
4. Electric heating equipment.
5. Packaged terminal air conditioners.

### **3.11 REPORT FORMS TO BE INCLUDED IN FINAL DATA**

1. Title Page:
  - a. Name of Testing, Adjusting, and Balancing Agency.
  - b. Address of Testing, Adjusting, and Balancing Agency.
  - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency.
  - d. Project name.
  - e. Project location.
  - f. Project Contractor.
  - g. Report date.
2. Summary Comments:
  - a. Design versus final performance.
  - b. Notable characteristics of system.
  - c. Description of systems operation sequence.
  - d. Summary of outdoor and exhaust flows to indicate building pressurization.
  - e. Nomenclature used throughout report.
  - f. Test conditions.
3. Instrument List:
  - a. Instrument.
  - b. Manufacturer.
  - c. Model number.
  - d. Serial number.
  - e. Range.
  - f. Calibration date.
4. Electric Motors:
  - a. Manufacturer.
  - b. Model/Frame.
  - c. HP/BHP and kW.
  - d. Phase, voltage, amperage; nameplate, actual, no load.

- e. RPM.
  - f. Service factor.
  - g. Starter size, rating, heater elements.
  - h. Sheave Make/Size/Bore.
5. Rooftop Units:
- a. Identification/number.
  - b. Location.
  - c. Manufacturer.
  - d. Model number.
  - e. Serial number.
  - f. Capacity.
  - g. Air flow, design and actual.
  - h. Static pressure drop, design and actual.
  - i. Refrigerant coil parameters
  - j. Electric heating coil parameters
  - k. Condensing unit parameters
6. Fans:
- a. Identification/number.
  - b. Location.
  - c. Manufacturer.
  - d. Model number.
  - e. Serial number.
  - f. Capacity.
  - g. Air flow, design and actual.
  - h. Static pressure drop, design and actual.
7. Air Inlets and Outlets:
- a. Identification/number.
  - b. Location.
  - c. Size.
  - d. Air flow, specified and actual.
8. Electric Heating Units and Packaged Terminal Air Conditioners:
- a. Manufacturer.
  - b. Model/Frame.

- c. Phase, voltage, amperage; nameplate
  - d. Set-point, design and actual.
9. Duct Leak Test:
- a. Description of ductwork under test.
  - b. Duct design operating pressure.
  - c. Duct design test static pressure.
  - d. Duct capacity, air flow.
  - e. Maximum allowable leakage duct capacity times leak factor.
  - f. Test apparatus:
    - 1) Blower.
    - 2) Orifice, tube size.
    - 3) Orifice size.
    - 4) Calibrated.
  - g. Test static pressure.
  - h. Test orifice differential pressure.
  - i. Leakage.

**END OF SECTION**

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## SECTION 23 09 00

**INSTRUMENTATION AND CONTROL FOR HVAC****PART 1 GENERAL****1.01 MEASUREMENT AND PAYMENT**

## A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

## A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

## B. National Fire Protection Association (NFPA)

1. NFPA 70 – 2020 National Electrical Code

## C. Underwriters Laboratories

1. UL 489 – 2016 Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

**1.03 SUBMITTALS**

## A. Submit the following in accordance with Sections 01 33 00 – Submittals, and 01 33 26 – Electrical Drawings and Data.

## B. RSN 23 09 00-1, Approval Drawings and Data:

1. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated:
  - a. Controlled Systems:
    - 1) Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, as described in Section 01 33 26 – Electrical Drawings and Data.
    - 2) Wiring diagrams as described in Section 01 33 26 – Electrical Drawings and Data.
    - 3) Written description of sequence of operation including schematic diagram.

- C. RSN 23 09 00-2, Final Drawings and Data:
  - 1. Operation and Maintenance Data:
    - a. Bound copy of signed, stamped, previously approved data from submittal RSN 23 09 00-1 in three-ring hard cover binder:
      - 1) As-built record drawings.
  - 2. Final drawings as described in Section 01 33 26 – Electrical Drawings and Data.

#### **1.04 SYSTEM PERFORMANCE**

- A. Comply with the following performance requirements:
  - 1. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
    - a. Space temperature: Plus, or minus 1 degree F.
    - b. Ducted air temperature: Plus, or minus 1 degree F.
    - c. Outside air temperature: Plus, or minus 2 degree F.
    - d. Temperature differential: Plus, or minus 0.25 degree F.

#### **1.05 SEQUENCE OF OPERATION**

- A. See mechanical drawings for control drawings and sequence of operation for RTU-1 and RTU-2. Drawings show general intent and minimum requirements. If more real or virtual points are required to provide sequences noted, it is Contractor's responsibility to provide additional equipment, accessories and programming time necessary to perform these sequences.
- B. Where control drawings and sequence of operation are not identified, provide industry standard sequences and control devices to accommodate proper system operation and safety control of all devices specified in Division 23 – Heating, Ventilating, and Air-Conditioning.
- C. Unless specifically noted otherwise modulate/staging down sequences shall be opposite of modulate/staging up sequence shown.

#### **1.06 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

#### **1.07 COORDINATION**

- A. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation. If more 120V power circuits are required than shown on drawings due to additional equipment required by Contractor, cost of additional power circuits and coordination of these power circuits with Division 26 - Electrical shall be responsibility of instrumentation and controls Contractor. All wiring shall comply with Division 26 - Electrical specifications.

## **PART 2 PRODUCTS**

### **2.01 DIRECT DIGITAL CONTROL SYSTEM**

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus and accessories to control mechanical systems of RTU-1 and RTU-2
- B. An operator interface that permits interaction with controllers via dynamic graphics with mechanical system, and control device depicted by point-by-point graphics.
- C. Control system shall meet requirements of ASHRAE 90.1.

### **2.02 OPERATOR INTERFACE**

- A. One touch screen-based microcomputer with minimum configuration as follows:
  - 1. Input/Output (I/O) capability from operator station.
  - 2. System security for each operator via software password and access levels.
  - 3. Automatic system diagnostics; monitor system and report failures.
  - 4. Dynamic graphic displays.
  - 5. Alarm processing, messages, and reactions.
  - 6. Trend logs retrievable in spreadsheets and database programs.
  - 7. Alarm and event processing.
  - 8. Object and property status and control.
  - 9. Automatic restart of field equipment on restoration of power.
  - 10. Data collection, reports, and logs. Include standard reports for the following:
    - a. Current values of all objects.
    - b. Current alarm summary.
    - c. Disabled objects.
    - d. Alarm lockout objects.
    - e. Logs.

### **2.03 LOCAL CONTROL UNITS**

- A. Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source:
  - 1. Units monitor or control each I/O point, process information, and download from or upload to operator interface or diagnostic terminal unit.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

- a. Discrete/digital, analog, and pulse I/O.
  - b. Monitoring, controlling, or addressing data points.
3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

## **2.04 I/O INTERFACE**

- A. Hardwired inputs and outputs may tie into system through controllers. Protect points so shorting will cause no damage to controllers:
  1. Binary Inputs: Allow monitoring of on-off signals without external power.
  2. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
  3. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
  4. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
  5. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
  6. Universal I/Os: Provide software selectable binary or analog outputs.
- B. I/O Spare Capacity: In addition to I/O points required to satisfy sequence of control, each control panel in system shall be provided with 10 percent spare capacity or at minimum one of each of the following: AI, AO, BI, BO whichever is greater. Universal inputs shall be an acceptable alternative to AI and BI points noted above.

## **2.05 POWER SUPPLIES**

- A. Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
  1. Output ripple of 5.0 mV maximum peak to peak.
  2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
  3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3-seconds without failure.

## **2.06 ELECTRONIC SENSORS**

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:

- a. Accuracy: Plus, or minus 0.5 deg F at calibration point.
- b. Wire: Twisted, shielded-pair cable.
- c. Insertion Elements in Ducts: Single point, 18-inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
- d. Averaging Elements in Ducts: 72-inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
- e. Outside Air Temperature Sensors: Watertight inlet fitting, shielded from direct sunlight.

## **2.07 STATUS SENSORS**

- A. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- B. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

## **2.08 ACTUATORS**

- A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque:
  1. Dampers: Size for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    - c. Dampers with 2- to 3-inch wg of Pressure Drop or Face Velocities of 1,000 to 2,500 fpm: Increase running torque by 1.5.
    - d. Dampers with 3- to 4-inch wg of Pressure Drop or Face Velocities of 2,500 to 3,000 fpm: Increase running torque by 2.0.
  2. Coupling: V-bolt and V-shaped, toothed cradle.
  3. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  4. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
  5. Power Requirements (Two-Position Spring Return): 24V ac.
  6. Temperature Rating: -22 to +122 degrees F.
  7. Run Time: 120-seconds.

## **2.09 CONTROL CABLE**

- A. All control devices and panels containing low voltage power sources shall inherently comply with NEC Class 2 requirements (current limiting) or shall be supplied with branch circuit fusing to limit control circuit current to NEC Class 2. All control transformers shall be of the inherent current limiting type or shall be installed with primary disconnects and overload protection.
- B. Shielded Cable: Twisted shielded cable shall be used where called for and where required to properly protect the control system from false signals and electrical noise. Shielding shall be fine braided tinned copper (90 percent coverage) or aluminum foil (100 percent coverage).
- C. Minimum Requirements:
  - 1. Communication Cable: Twisted shielded pair, 18-gauge.
  - 2. Analog Input: Twisted shielded two, three, or four-wire as required, 18-gauge.
  - 3. Binary Input: 18-gauge.
  - 4. Analog Output: Twisted shielded, 18-gauge.
  - 5. Binary Output: 18-gauge.

## **PART 3 EXECUTION**

### **3.01 SYSTEM PERFORMANCE**

- A. System shall be complete in all respects, put in operation, tested and calibrated prior to occupied conditions. Provide time for occupancy adjustments after building is occupied. Contractor is responsible for providing all sequences of operations specified herein or on mechanical drawings even if equipment and controls are provided by others. Sequences specified in other sections, if equipment and controls are provided by others, Contractor shall still be responsible for verifying sequences of controls and coordination.

### **3.02 EXAMINATION**

- A. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

### **3.03 INSTALLATION**

- A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Calibrate all sensors for the project elevation.
- C. Connect and configure equipment and software to achieve sequence of operation specified.

- D. Verify location of temperature sensors, and other exposed control sensors with drawings and room details before installation.
- E. Install thermostats and temperature sensors where they will be unaffected by the sun. Avoid mounting on outside wall. Where such devices must be mounted on an outside wall, provide an insulating base.
- F. Sensors shall be installed to sense correct temperature of controlled medium only, within vibration and velocity limits of sensing element. Thermally isolate elements from brackets and supports to respond to air temperature only. Seal all duct penetrations air tight.
- G. Sensors and other control devices shall be installed to be readily accessible and to permit quick and easy replacement. Flush mount with metal covers suitable for painting to match finished surface.
- H. Install automatic dampers in accordance with Section 23 33 00 – Air Duct Accessories.
- I. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- J. Install labels and nameplates to identify control components as noted below and in accordance with Section 23 05 53 – Identification - HVAC:
  - 1. Identification: Tag or color-code all wiring at each end and necessary junction points and match tagging numbers or color-coding shown on control drawings. Clearly label function and setting. Identification shall cross-reference control diagrams.
- K. Control Panels:
  - 1. Provide and install local control panels for each system. Group together into one panel when multiple systems are in one equipment room.
  - 2. Panels shall be totally enclosed with hinged door and containing associated control components such as controllers, relays, switches, gauges, microprocessors, communication interface, override timers, etc. Panel to meet NEMA 4X requirements with proper bracing for rigid wall or floor mounting.
  - 3. Unless indicated otherwise all controlling devices (including duct and immersion controllers, relays, PE switches, EP valves, selectors, networks, and switches) shall be panel mounted.

### **3.04 SAFETIES**

- A. Duct Smoke Detectors: Each air-moving system with design capacity greater than 2,000 cfm shall have a smoke detector provided in duct upstream of any filters, or air conditioning devices (coils, evaporative cooling media, etc.). Wire smoke detector(s) to shut down unit in both hand (manual) and automatic operation. When smoke is detected, detector(s) shall stop fan(s), open relief hood air damper(s) and close outside air damper(s). Control must function independently of local unit control system:

1. Location of smoke detectors shall be as shown on drawings, provided and installed by Division 28 – Electrical Safety and Security. Where not shown on drawings default location shall be in air handling unit outside air section.
2. Wiring of detectors to fire alarm panel by Division 28 – Electrical Safety and Security.

### **3.05 ELECTRICAL WIRING AND CONNECTION INSTALLATION**

- A. Install raceways, boxes, and cabinets in accordance with Division 26 – Electrical.
- B. Install building wire and cable in accordance with Division 26 – Electrical.
- C. Install signal and communication cable in accordance with the following:
  1. Conceal cable in conduit unless run in raceway. Flexible conduit shall be limited to 2-foot lengths maximum.
  2. All wiring shall be installed in neat and workmanlike manner.
  3. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  4. Number-code or color-code conductors for future identification and service of control system.
  5. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
  6. Cable shall not be installed closer than 6-feet from high power transformers or run parallel within 6-feet of electrical high-power cables. Care shall be taken to route cable as far from interference generating devices as possible.
  7. Temperature control wiring shall not be run in conduit with power wiring. Analog or communication wiring shall not be run in same conduit which has highly inductive loads such as contactors or coils.
  8. Grounding: In accordance with Division 26 – Electrical.
  9. Wiring of control devices by others: Control devices carrying full load current furnished by this specification Division and wired by Division 26 – Electrical shall be located at device being controlled, unless otherwise shown on drawings.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### **3.06 CONTRACTOR FIELD QUALITY CONTROL**

- A. Perform the following field tests:

1. Operational Test: After electrical circuitry has been energized, start HVAC equipment to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  2. Test and adjust controls and safeties.
  3. Test each point through its full operating range to verify that safety and operating control set points are as required.
  4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  5. Test each system for compliance with sequence of operation.
  6. Test software and hardware interlocks.
  7. DDC Verification:
    - a. Verify wires at control panels are tagged with service designation and approved tagging system.
    - b. Verify spare I/O capacity has been provided.
    - c. Verify DDC controllers are protected from power supply surges.
- B. Calibrate test instruments.
- C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### **3.07 ADJUSTING**

- A. Calibrating and Adjusting:
1. Calibrate instruments.
  2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
  3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
  4. Control System Inputs and Outputs:
    - a. Check analog inputs at 0, 50, and 100 percent of span.
    - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    - c. Check digital inputs using jumper wire.
    - d. Check digital outputs using ohmmeter to test for contact making or breaking.
    - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Temperature:
    - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    - b. Calibrate temperature switches to make or break contacts.
  6. Stroke and adjust control valves and dampers without positioners, following manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
  7. Provide diagnostic and test instruments for calibration and adjustment of system.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12-months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

### **3.08 TRAINING**

- A. Engage factory-authorized service representative to train maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Provide minimum of 8-hours of training. Training session shall be conducted at building. Two copies of as-built drawings and operation and maintenance manuals shall be provided at training session.

**END OF SECTION**

**SECTION 23 31 00**  
**HVAC DUCTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM):

- |    |                      |  |
|----|----------------------|--|
| 1. | ASTM C534/C534M-2019 | Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form |
| 2. | ASTM C920-2018       | Elastomeric Joint Sealants   |
| 3. | ASTM C1071-2019      | Fibrous Glass Duct Lining Insulation   |

B. Code of Federal Regulations (CFR)

- |    |                |  |
|----|----------------|--|
| 1. | 40 CFR 59-2018 | Consumer and Commercial Products, Group IV: Control Techniques Guidelines In lieu of Regulations for Miscellaneous Metal Products Coatings, Plastic Parts Coatings, Auto and Light-Duty Truck Assembly Coatings, Fiberglass Boat Manufacturing Materials, and Miscellaneous Industrial Adhesives |
|----|----------------|--|

C. North American Insulation Manufacturer's Association (NAIMA)

- |    |             |                          |
|----|-------------|--------------------------|
| 1. | NAIMA-AH124 | Fibrous Glass Duct Liner |
|----|-------------|--------------------------|

D. National Fire Protection Association (NFPA):

- |    |               |  |
|----|---------------|--|
| 1. | NFPA 90A-2018 | Installation of Air Conditioning and Ventilating Systems |
|----|---------------|--|

E. Sheet Metal and Air Conditioning Contractors (SMACNA):

- |    |                 |   |
|----|-----------------|---|
| 1. | SMACNA 008-2008 | IAQ Guidelines for Occupied Building's Under Construction |
| 2. | SMACNA 016-2012 | HVAC Air Duct Leakage Test Manual                         |

3. SMACNA 1966-2006 HVAC Duct Construction Standard-Metal and Flexible
- F. Underwriters Laboratories Inc. (UL):
1. UL 181A-2013 Factory-Made Air Ducts and Connectors
  2. UL 723-2018 Tests for Surface Burning Characteristics of Building Materials

### **1.03 PERFORMANCE REQUIREMENTS**

- A. Variations of duct configuration or sizes are not permitted except by written permission by Government.

### **1.04 ENVIRONMENTAL REQUIREMENTS**

- A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers. Maintain temperatures during installation of duct sealant.

### **1.05 FIELD MEASUREMENTS**

- A. Verify field measurements prior to fabrication.

## **PART 2 PRODUCTS**

### **2.01 INTERIOR SINGLE WALL METAL DUCT**

- A. General Fabrication Requirements: Comply with SMACNA 1966 based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints and Longitudinal Seams: Select joint and seam types and fabricate according to SMACNA 1966 for static-pressure class, applicable sealing requirements, duct-support intervals, and other provisions.
- C. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA 1966 for static-pressure class, applicable sealing requirements, duct-support intervals, and other provisions.

### **2.02 EXTERIOR SINGLE WALL RECTANGULAR METAL DUCTS**

- A. 16-gauge galvanized steel sheet with all transverse joints and longitudinal seams welded watertight. Duct to be installed per SMACNA 1966 instructions.
- B. Equipment Connection: Duct to be connected to rooftop unit using flexible duct connectors per SMACNA 1966 instructions for single wall ductwork and rooftop installation applications.

## 2.03 DOUBLE WALL RECTANGULAR DUCTS

- A. Rectangular Ducts: Fabricate ducts with indicated dimensions for inner duct.
- B. Outer Duct: 16-gauge galvanized steel sheet with all transverse joints and longitudinal seams welded watertight. Duct to be installed per SMACNA 1966 instructions for double wall ductwork in all other regards.
- C. Equipment Connection: Duct to be connected to rooftop unit using flexible duct connectors per SMACNA 1966 instructions for double wall ductwork and rooftop installation applications.
- D. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A:
  - 1. Maximum Thermal Conductivity: 0.25 Btu x in/h x sq. ft. x degree F at 75 degree F mean temperature.
- E. Inner Duct: Minimum 0.028-inch solid galvanized sheet steel:
  - 1. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA 1966 for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions.
  - 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA 1966 for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions.

## 2.04 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A; and with NAIMA AH124:
  - 1. Maximum Thermal Conductivity:
    - a. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x degree F at 75 degree F mean temperature.
    - b. Antimicrobial Erosion-Resistant Coating: Apply to surface of liner that will form interior surface of duct to act as moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by NRTL and registered by EPA for use in HVAC systems.
    - c. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916:
      - 1) For indoor applications, adhesive shall have VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## **2.05 SEALANT AND GASKETS**

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an National Recognized Testing Laboratory:
1. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  8. Service: Indoor or outdoor.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C920:
1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.
  3. Grade: NS.
  4. Class: 25.
  5. Use: O.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## **PART 3 EXECUTION**

### **3.01 DUCTWORK FABRICATION**

- A. Fabricate and support ducts in accordance with SMACNA 1966. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Increase duct sizes gradually, not exceeding 15 degrees divergence unless shown otherwise on drawings.

- C. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape:
  - 1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
  - 2. All sealing products must bear UL approval markings.

### **3.02 DUCT SCHEDULE**

- A. Duct leakage, pressure and seal classification criteria based upon SMACNA 016.
- B. Fabricate ducts with galvanized sheet steel unless specified otherwise below.
- C. Supply Ducts:
  - 1. Ducts Connected to Rooftop Units:
    - a. Ducts exterior to building: Metal, double wall.
    - b. Ducts interior to building: Metal, single wall
    - c. Pressure Class: Positive 3-inch wg.
    - d. Minimum SMACNA Seal Class: A.
    - e. SMACNA Leakage Class for Rectangular: 6.
    - f. SMACNA Leakage Class for Round: 6.
- D. Return Ducts:
  - 1. Ducts Connected to Rooftop Units:
    - a. Ducts exterior to building: Metal, single wall.
    - b. Ducts interior to building: Metal, single wall.
    - c. Pressure Class: Positive 3-inch wg.
    - d. Minimum SMACNA Seal Class: A.
    - e. SMACNA Leakage Class for Rectangular: 6.
    - f. SMACNA Leakage Class for Round: 6.
- E. Single Wall Duct Liner:
  - 1. Supply Air Ducts: 1-inch thick.
  - 2. Return Air Ducts: None
- F. Double-Wall Duct Interstitial Insulation:
  - 1. Supply Air Ducts: 1 1/2-inches thick.
- G. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA 1966:

- a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
- b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
- c. Mitered Type RE 2 with vanes complying with SMACNA 1966.

### **3.03 INSTALLATION**

- A. Construct ductwork to NFPA 90A.
- B. Install ducts with fewest possible joints.
- C. Install factory or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- D. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- F. Install ducts with a clearance of 1-inch.
- G. Where ducts pass through interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1 1/2-inches.
- H. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA 008.
- I. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8-inch and smaller.
- J. Use double nuts and lock washers on threaded rod supports.
- K. Exhaust outlet locations to be as shown on drawings. Maintain the following separations:
  1. Minimum Distance from Property Lines: 3-feet.
  2. Minimum Distance from Building Openings: 3-feet.
  3. Minimum Distance from Outside Air Intakes: 10-feet.
- L. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- M. Any scratched or damaged ductwork shall be repaired in accordance with Section 09 96 20 – Coatings.

### **3.04 INTERFACE WITH OTHER PRODUCTS**

- A. Install openings in ductwork where required to accommodate thermometers and controllers. Install Pitot tube openings for testing of systems. Install Pitot tube complete with metal can, spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

### **3.05 CLEANING**

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

**END OF SECTION**

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**SECTION 23 33 00**  
**AIR DUCT ACCESSORIES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. Air Movement and Control Association International, Inc. (AMCA)

1. AMCA 500-L-12(2015) Louvers, Dampers, and Shutters.

B. Sheet Metal and Air Conditioning Contractors (SMACNA)

1. SMACNA 1966-2006 HVAC Duct Construction Standard - Metal and Flexible

C. Underwriters Laboratories, Inc. (UL)

1. UL 181-2017 Factory-Made Air Ducts and Connectors

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 23 33 00-1, Approval Data:

1. Submit manufacturer's product data on each type of duct accessory.

**1.04 QUALITY ASSURANCE**

A. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

**1.05 DELIVERY, STORAGE AND HANDLING**

A. Protect dampers from damage to operating linkages and blades.

B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

C. Protect from weather and construction dust.

D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

## **1.06 FIELD MEASUREMENTS**

- A. Verify field measurements prior to fabrication.

## **PART 2 PRODUCTS**

### **2.01 BACK-DRAFT DAMPERS**

- A. Multi-Blade, Parallel-action, gravity-balanced, Galvanized 16-gage thick steel.
- B. Blades, maximum 6-inch width, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin.
- C. Furnish dampers with adjustment device to permit setting for varying differential static pressure.
- D. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

### **2.02 DUCT ACCESS DOORS**

- A. Fabricate in accordance with SMACNA 1966.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1-inch thick insulation with sheet metal cover:
  - 1. Less than 12-inches square, secure with sash locks.
  - 2. Up to 18-inches square: Furnish two hinges and two sash locks.
  - 3. Up to 24- x 48-inches: Three hinges and two compression latches.
  - 4. Larger sizes: Furnish additional hinge.
  - 5. Access panels with sheet metal screw fasteners are not acceptable.

### **2.03 MANUAL VOLUME DAMPERS**

- 1. Standard, Steel, Manual Volume Dampers:
  - a. Standard leakage rating.
  - b. Suitable for horizontal or vertical applications.
  - c. Frames:
    - 1) Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel
    - 2) Mitered and welded corners.
    - 3) Flanges for attaching to walls and flangeless frames for installing in ducts.

- d. Blades:
  - 1) Multiple or single blade.
  - 2) Parallel- or opposed-blade design.
  - 3) Stiffen damper blades for stability.
  - 4) Galvanized-steel, 0.064-inch thick.
- e. Blade Axles: Galvanized steel.
- f. Bearings:
  - 1) Oil-impregnated bronze or Molded synthetic.
  - 2) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- g. Tie Bars and Brackets: Galvanized steel.

#### **2.04 TURNING VANES**

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- B. Fabricated in accordance with SMACNA 1966.
- C. Vane Construction: Double wall.

#### **2.05 FLEXIBLE CONNECTORS**

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3 1/2-inches wide attached to two strips of 2 3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene:
  - 1. Minimum Weight: 26 oz/sq. yd.
  - 2. Tensile Strength: 480 lbf/inch in warp and 360 lbf/inch in filling.
  - 3. Service Temperature: Minus 40 to plus 200 degrees F.

#### **2.06 DUCT ACCESSORY HARDWARE**

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.

- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## **2.07 STATIC PRESSURE GAGES**

- A. Dial Gages: 3 1/2-inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full-scale accuracy.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with SMACNA 1966. Refer to Section 23 31 00 - HVAC Ducts for duct construction and pressure class.
- B. Install volume dampers at points on supply diffuser takeoffs.. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- C. Install backdraft and/or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan, or as noted on the control drawing. Where dampers are not noted on control drawings install backdraft damper on inlet.
- D. Access Doors: Install access doors every 50-feet of straight duct and as indicated on drawings.
- E. Install access doors with swing against duct static pressure.
- F. Access door sizes shall be as noted or as required for proper access and service to equipment. Minimum sizes shall be as follows:
  - a. Two-Hand Access: 12- by 6-inches.
- G. Install permanent duct test holes and plugs where required for testing and balancing purposes.
- H. Any scratched or damaged metal air duct accessories shall be repaired in accordance with Section 09 96 20 – Coatings.
- I. Install flexible connectors to connect ducts to equipment.

**END OF SECTION**

**SECTION 23 33 13**  
**DRAFT CONTROL DAMPER**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for applicable items of work.

**1.02 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 23 33 13-1, Approval Data:

1. Installation methods.
2. Technical data.

C. RSN 23 33 13-2, Final Data:

1. Operation and Maintenance Data.
2. Bound copy of signed, stamped, previously approved data.

**PART 2 PRODUCTS**

**2.01 DRAFT CONTROL DAMPER**

A. Draft Control Damper: The following draft control dampers are acceptable:

1. Model MG-1, size as shown on drawings. Manufactured by Field Controls, LLC, 2630 Airport Road, Kinston, NC, 28504, [www.fieldcontrols.com](http://www.fieldcontrols.com), or equal with the following essential characteristics:
  - a. Construction:
    - 1) Material: Galvanized steel.
    - 2) Coating: Baked enamel.
  - b. Double acting leaf opens to relieve positive or negative vent system pressures.
  - c. Adjustments using weights, accurate from 0.01- to 0.1-inch water gauge static pressure.

**PART 3 EXECUTION****3.01 GENERAL**

- A. Install draft damper per manufacturer's recommendations and as shown on drawings.
- B. Initially adjust weights to positive and negative 0.05-inch water gauge static pressure.
- C. Protect damper when applying foam insulation to prevent interference with damper operation.

**END OF SECTION**

**SECTION 23 34 00**  
**HVAC FANS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCES**

- A. Air Movement and Control Association International, Inc. (AMCA):
1. AMCA 204 - 2005 Balance Quality and Vibration Levels for Fans
  2. AMCA 210 - 2016 Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
- B. Underwriters Laboratories Inc. (UL):
1. UL 705 - 2017 Power Ventilators

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals, and 01 33 26 – Electrical Drawings and Data.
- B. RSN 23 34 00-1, Approval Data:
1. Submit manufacturer's product data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements. Include submittal requirements of 23 05 13 – Common Motor Requirements for HVAC Equipment.
- C. RSN 23 34 00-2, Final Data:
1. Operation and Maintenance Data. Submit manufacturer's operation and maintenance manuals including instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
  2. Bound copy of signed, stamped, previously approved data.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Protect motors, shafts, and bearings from weather and construction dust.

## **PART 2 PRODUCTS**

### **2.01 CEILING-MOUNTING VENTILATORS (VF-1)**

- A. Description: Upblast centrifugal fans designed for installing on roof.
- B. Drive: Direct
- C. Housing: Aluminum, lined with acoustical insulation.
- D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Rubber-in-shear vibration isolators.
- H. Performance Ratings: Conform to AMCA 210.
- I. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- J. Balance Quality: Conform to AMCA 204.
- K. See schedule on drawings for additional information.
- L. Coating: Provide epoxy powder coating or manufacturer recommended coating for corrosion resistance. Include UV resistant top coat for outdoor installation.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install backdraft dampers on inlet to roof exhaust fans.
- B. Install safety screen where inlet or outlet is exposed.
- C. Provide sheaves required for final air balance.

### **3.02 CLEANING**

- A. Vacuum clean inside of fan cabinet.

### **3.03 PROTECTION OF FINISHED WORK**

- A. Do not operate fans until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

**END OF SECTION**

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**SECTION 23 37 00**  
**AIR INLETS AND OUTLETS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. Air Movement and Control Association International, Inc. (AMCA):

1. AMCA 500-L-12(2015) Louvers, Dampers, and Shutters

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. ASHRAE 70-2006 Rating the Performance of Air Outlets and Inlets

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 23 37 00-1, Approval Data:

1. All Equipment:
  - a. Manufacturer's product data that includes sizes, finish, and type of mounting.

C. RSN 23 37 00-2, Final Data:

1. Bound copy of signed, stamped, previously approved data.

**PART 2 PRODUCTS**

**2.01 SUPPLY AND RETURN GRILLES**

A. Supply Grille and Return Grilles:

1. Type: Extruded aluminum frame, individually adjustable aluminum airfoil blades on 1.25-inch centers, mitered corners.
2. See schedule on drawings for additional information.

B. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

**2.02 STATIONARY LOUVERS:**

- A. Type: Blades on 45-degree slope with center baffle and return bend, heavy channel frame, drainable.
- B. Fabrication: Aluminum, with factory baked enamel finish. Finish color to be selected by Government from approval data submittal.
- C. Bird Screen: Bird screen with 1/2-inch square mesh for exhaust and 3/4-inch for intake.
- D. Free Area Required: 54 percent:
  - 1. Meet maximum static pressure losses listed on drawing schedule. Performance data to be AMCA 500 certified.
- E. See schedule on drawings for additional information.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Install diffusers to ductwork with airtight connection.
- B. Outlets and Inlets:
  - 1. Drawings indicate general arrangement of ducts, fittings, and accessories.
  - 2. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop.
  - 3. Make final locations where indicated, as much as practical.

**END OF SECTION**

**SECTION 23 73 13**  
**PACKAGED ROOFTOP UNITS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. American Bearing Manufacturers Association (ABMA)

1. ABMA 9-2015 Load Ratings and Fatigue Life for Ball Bearings

B. Air Movement and Control Association International, Inc. (AMCA):

1. AMCA 210-2016 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
2. AMCA 300-2014 Reverberant Room Method for Sound Testing of Fans
3. AMCA 301-2014 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
4. AMCA 500-L-12(2015) Louvers, Dampers, and Shutters

C. Air-Conditioning Heating and Refrigeration Institute (AHRI):

1. ARI 430-2009 Central Station Air-Conditioning Units.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. ASHRAE 52.1-1992 Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 52.2-2017 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
3. ASHRAE 62.1-2019 Ventilation for Acceptable Indoor Air Quality
4. ASHRAE 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings.

- E. ASTM International:
1. ASTM B88-2016 Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
  2. ASTM C916-2014 Adhesives for Duct Thermal Insulation
  3. ASTM C916-2014 Fibrous Glass Duct Lining Insulation
- F. National Electrical Manufacturers Association (NEMA):
1. NEMA MG 1-2016 Motors and Generators.
- G. National Fire Protection Association (NFPA):
1. NFPA 70-2020 National Electric Code
  2. NFPA 90A-2018 Installation of Air Conditioning and Ventilating Systems
- H. Sheet Metal and Air Conditioning Contractors (SMACNA):
1. SMACNA 1966-2006 HVAC Duct Construction Standard-Metal and Flexible
- I. Underwriters Laboratories Inc. (UL):
1. UL 181A-2013 Factory-Made Air Ducts and Connectors
  2. UL 1995-2015 Heating and Cooling Equipment

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 23 73 13-1, Approval Data:
1. Product Data: For each air-handling unit indicated.
  2. Unit dimensions and weight.
  3. Cabinet material, metal thickness, finishes, insulation, and accessories.
  4. Fans:
    - a. Certified fan-performance curves with system operating conditions indicated.
    - b. Certified fan-sound power ratings.
    - c. Fan construction and accessories.
    - d. Motor ratings, electrical characteristics, and motor accessories.
  5. Certified coil-performance ratings with system operating conditions indicated.
  6. Dampers, including housings, linkages, and operators.
  7. Filters with performance characteristics.

- C. RSN 23 73 13-2, Final Data:
  - 1. Bound copy of signed, stamped, previously approved data.

#### **1.04 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

#### **1.05 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set(s) for each air-handling unit.
  - 2. Gaskets: One set(s) for each access door.
  - 3. Fan Belts: One set(s) for each air-handling unit fan.

#### **1.06 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430 and shall be listed and labeled by ARI.
- D. ASHRAE 62.1 Compliant.
- E. ASHRAE 90.1 Compliant.
- F. Comply with NFPA 70.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL**

- A. Self-contained, factory-assembled and -wired unit; consisting of cabinet, compressor, evaporator fan, evaporator coil, air filters, and controls; and fully charged with refrigerant and oil:
  - 1. Condenser: Integral air-cooled condenser.

## **2.02 COMPRESSOR**

- A. Description: Hermetically sealed, 3600 rpm maximum, and resiliently mounted with positive lubrication and internal motor protection.
- B. Compressor Type: Scroll.

## **2.03 EVAPORATOR COIL**

- A. Direct-Expansion Coil: Seamless copper tubes expanded into aluminum fins.
  - 1. Corrosion-Resistant Treatment: Phenolic coating applied with multiple dips and baked.
- B. Refrigerant Circuits: Separate circuit for each compressor, with externally equalized thermal-expansion valve, filter-dryer, and charging valves:
  - 1. Coil Type: Continuous circuit.
  - 2. Tube Material: Copper.
  - 3. Fin Type: Plate.
  - 4. Fin Material: Aluminum.
  - 5. Headers: Provide insulated cover to conceal headers exposed outside casings.

## **2.04 INTEGRAL AIR-COOLED CONDENSER**

- A. Description: Factory assembled and tested; consisting of condenser coil, fans and motors, and cabinet:
  - 1. Condenser Coil: Aluminum-fin copper tube with integral subcooler; leak tested to 150 psig:
    - a. Tube Material: Copper.
    - b. Fin Type: Plate.
    - c. Fin Material: Aluminum.
    - d. Headers: Provide insulated cover to conceal headers exposed outside casings.
  - 2. Condenser Fan: Direct-drive propeller type with permanently lubricated motor with built-in thermal-overload protection.
  - 3. Low Ambient Control: Cycles fans to permit operation down to 0 deg F.

## **2.05 REFRIGERATION SYSTEM**

- A. Description: Factory assembled and tested, and charged with CFC-free refrigerant; consisting of piping and accessories connecting compressor, evaporator coil, and condenser coil, and including the following:

1. Four-way reversing valve and suction-line accumulator.
  2. Expansion valve with replaceable thermostatic element.
  3. Refrigerant dryer.
  4. High-pressure switch.
  5. Low-pressure switch.
  6. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
  7. Low ambient switch.
  8. Brass service valves installed in discharge and liquid lines.
- B. Refrigerant: R-410A.
- C. Controller: Unit mounted with disconnecting means and overcurrent protection:
- a. Integrate with DDC system. See 23 09 00 – Instrumentation and Control for HVAC.

## **2.06 UNIT CASINGS**

- A. Unit rated for outdoor use.
- B. General Fabrication Requirements for Casings:
1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
  2. Casing Joints: Sheet metal screws or pop rivets.
  3. Sealing: Seal all joints with water-resistant sealant.
  4. Factory Finish for Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
  5. Casing Coating: Powder-baked enamel.
  6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Casing Insulation and Adhesive:
1. Materials: ASTM C 1071, Type II.
  2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section:
    - a. Liner Adhesive: Comply with ASTM C 916, Type I.

- b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
  3. Location and Application: Encased between outside and inside casing.
- D. Inspection and Access Panels and Access Doors:
  1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
  2. Inspection and Access Panels:
    - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
    - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
  3. Access Doors:
    - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
    - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    - c. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
    - d. Size: At least 18-inches wide by full height of unit casing up to maximum height of 60-inches.
  4. Locations and Applications:
    - a. Fan Section: Doors and inspection and access panels
    - b. Coil Section: Inspection and access panel.
    - c. Damper Section: [Inspection and access panels] [Doors].
    - d. Filter Section: Doors large enough to allow periodic removal and installation of filters.
    - e. Compressor Section: Doors.
    - f. Condenser Section: Doors.

- E. Condensate Drain Pans:
1. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection:
    - a. Depth: Minimum of 2-inches deep.
  2. Single-wall, stainless-steel sheet.
  3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
  4. Pan-Top Surface Coating: Asphaltic waterproofing compound.
- F. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

## 2.07 FAN, DRIVE, AND MOTOR SECTION

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower:
1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment:
    - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
    - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell:
1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  2. Horizontal-Flanged, Split Housing: Bolted construction.
  3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
  4. Flexible Connector: Factory fabricated with a fabric strip 3 1/2-inches wide attached to 2 strips of 2 3/4-inch wide, 0.028-inch thick, galvanized-steel sheet or 0.032-inch thick aluminum sheets; select metal compatible with casing:
    - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1:
      - 1) Fabric Minimum Weight: 26 oz./sq. yd.
      - 2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      - 3) Fabric Service Temperature: -40 to plus 200 deg F.

- C. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- D. Fan Shaft Bearings: Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 120,000 hours according to ABMA 9.
- E. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor:
1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  2. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
  3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA 1966: 0.1046-inch thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.
- F. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 2-inches.
- G. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 – Common Motor Requirements for HVAC Equipment:
1. Enclosure Type: Totally enclosed, fan cooled.
  2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  5. Mount unit-mounted disconnect switches on exterior of unit.
- H. Variable Frequency Drive (VFD) Inverter:
1. Factory-mounted, wired and tested.
  2. Integrate with DDC system. See Section 23 09 00 – Instrumentation and Control for HVAC.
  3. Insulated gate bi-polar transistors used to produce output width modulation waveform.
  4. Capable of operation at frequency of 8 kHz.
  5. Capable of critical frequency avoidance.

6. Self-diagnostic.
7. On-board keypad with internal memory for of storage of configuration.
8. RS485 communications capability.
9. Thermal overload protection (electronic).
10. 5 percent swinging chokes for harmonic duction.
11. Conformal coated printed circuit boards.

## **2.08 HEATING COIL SECTION**

### **A. Electrical Heating Coils, Controls, and Accessories: Comply with UL 1995:**

1. Casing Assembly: galvanized-steel frame.
2. Sheathed Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
3. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
4. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
5. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
6. Controller: Unit mounted with disconnecting means and overcurrent protection:
  - a. Integrate with DDC system. See Section 23 09 00 – Instrumentation and Control for HVAC.
  - b. Magnetic contactor.
  - c. Solid-state, stepless pulse controller.
  - d. Toggle switches, one per step.
  - e. Step controller.
  - f. Time-delay relay.
  - g. Pilot lights, one per step.
  - h. Airflow proving switch.

## **2.09 AIR FILTRATION SECTION**

### **A. General Requirements for Air Filtration Section:**

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

### **B. Disposable Panel Filters:**

1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness: 2-inches.
3. Arrestance (ASHRAE 52.1): 80.
4. Merv (ASHRAE 52.2): 8.
5. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
6. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

### **C. Filter Gage:**

1. 3 1/2-inch diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 1.0-inch wg.

## **2.10 DAMPERS**

A. General Requirements for Dampers: Leakage rate, according to AMCA 500 not to exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Electronic Damper Operators: See Section 23 09 00 – Instrumentation and Control for HVAC.

C. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, galvanized-steel dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

## **2.11 SUPPLY FAN CAPACITIES AND CHARACTERISTICS**

### **A. Supply Fan:**

1. Class I: AMCA 99-2408.
2. Drive: V-belt.
3. Type: Galvanized-steel, forward-curved centrifugal:

### **B. Source quality control:**

1. Fan Sound-Power Level Ratings: Comply with AMCA 301, Test fans according to AMCA 300, Fans shall bear AMCA-certified sound ratings seal.
2. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210.

## **2.12 ECONOMIZER**

- A. Damper assembly allowing induction of up to 100 percent outside air to maintain selected mixed-air temperature; and exhaust damper and spring-return, low-voltage, modulating damper motor with minimum position adjustment.

## **2.13 VIBRATION ISOLATION PAD**

- A. ASHRAE Type I fiberglass pad fitting for equipment.

## **2.14 CONTROLS**

- A. See Drawings and Section 23 09 00 – Instrumentation and Control for HVAC.

## **2.15 CONTROL CABLE**

- A. All control devices and panels containing low voltage power sources shall inherently comply with NEC Class 2 requirements (current limiting) or shall be supplied with branch circuit fusing to limit control circuit current to NEC Class 2. All control transformers shall be of inherent current limiting type or shall be installed with primary disconnects and overload protection.
- B. Shielded Cable: Twisted shielded cable shall be used where called for and where required to properly protect the control system from false signals and electrical noise. Shielding shall be fine braided tinned copper (90 percent coverage) or aluminum foil (100 percent coverage).
- C. Minimum Requirements:
1. Communication Cable: Twisted shielded pair, 18-gauge.
  2. Analog Input: Twisted shielded two, three, or four-wire as required, 18-gauge.

3. Binary Input: 18-gauge.
4. Analog Output: Twisted shielded, 18-gauge.
5. Binary Output: 18-gauge.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Equipment Mounting: Install rooftop unit on vibration isolation pad.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

### **3.03 CONNECTIONS**

- A. Install piping adjacent to air-handling unit to allow service and maintenance.
- B. Connect condensate drain pans using NPS 1 1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- C. Refrigerant Piping: Install shutoff valve and union or flange at each supply and return connection.
- D. Connect duct to air-handling units with flexible connections.

### **3.04 ELECTRICAL WIRING AND CONNECTION INSTALLATION**

- A. Install signal and communication cable in accordance with the following:
1. Conceal cable in conduit unless run in raceway. Flexible conduit shall be limited to 2-foot lengths maximum.
  2. All wiring shall be installed in neat and workmanlike manner.
  3. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  4. Number-code or color-code conductors for future identification and service of control system.
  5. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
  6. Temperature control wiring shall not be run in conduit with power wiring. Analog or communication wiring shall not be run in same conduit which has highly inductive loads such as contactors or coils.
  7. Grounding: In accordance with Division 26 – Electrical.
  8. Wiring of control devices by others: Control devices carrying full load current furnished by this specification Division and wired by Division 26 – Electrical shall be located at device being controlled, unless otherwise shown on drawings.

### **3.05 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections:
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
1. Charge refrigerant coils with refrigerant and test for leaks.
  2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.06 STARTUP SERVICE**

- A. Perform startup service:
1. Complete installation and startup checks according to manufacturer's written instructions.
  2. Verify that shipping, blocking, and bracing are removed.
  3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
  4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
  5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
  6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
  7. Comb coil fins for parallel orientation.
  8. Verify that proper thermal-overload protection is installed for electric coils.
  9. Install new, clean filters.
  10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

### **3.07 CLEANING**

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

### **3.08 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

**END OF SECTION**

**SECTION 23 81 00**  
**DIRECT EXPANSION REFRIGERATION AIR CONDITIONERS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. Air-Conditioning Heating and Refrigeration Institute (AHRI)

1. ARI 210/240-2008 Unitary Air-Conditioning and Air-Source Heat Pump Equipment
2. ARI 270-2008 Sound Rating of Outdoor Unitary Equipment
3. ARI 310/380-2004 Packaged Terminal Air Conditioners and Heat Pumps

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 15-2019 Safety Standard for Refrigerant Systems
2. ASHRAE 62.1-2019 Ventilation for Acceptable Indoor Air Quality
3. ASHRAE 90.1-2019 Energy Standard for Buildings except Low-Rise Residential Buildings

C. ASTM International (ASTM)

1. ASTM B280-2019 Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

D. National Electrical Manufacturers Association (NEMA)

1. NEMA MG 1-2016 Motors and Generators

E. National Fire Protection Association (NFPA)

1. NFPA 90A-2018 Installation of Air Conditioning and Ventilating Systems

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals, and 01 33 26 – Electrical Drawings and Data.
- B. RSN 23 81 00-1, Approval Drawings and Data:
  - 1. Submit manufacturer's product data indicating:
    - a. Cooling and heating capacities.
    - b. Dimensions.
    - c. Weights.
    - d. Rough-in connections and connection requirements.
    - e. Duct connections.
    - f. Electrical requirements with electrical characteristics and connection requirements.
    - g. Controls.
    - h. Accessories.
    - i. Compliance with ASHRAE 90.1.
    - j. Sound ratings.
- C. RSN 23 81 00-3, Final Drawings and Data:
  - 1. Operation and Maintenance Data. Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.
  - 2. Bound copy of signed, stamped, previously approved data.

### **1.04 QUALITY ASSURANCE**

- A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.
- B. Cooling Capacity: Rate in accordance with ARI 210/240.
- C. Sound Rating: Measure in accordance with ARI 270.
- D. Insulation and adhesives: Meet requirements of NFPA 90A.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

- B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

## **PART 2 PRODUCTS**

### **2.01 PACKAGED TERMINAL AIR CONDITIONING, (PTAC-1,4)**

- A. Description: Factory-assembled and -tested, self-contained, packaged terminal air conditioner with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil; with hardwired chassis. To comply with minimum efficiency requirements of ASHRAE 90.1.
- B. Cabinet: 0.052-inch thick steel with removable front panel with concealed latches:
  - 1. Mounting: Wall with wall sleeve. Galvanized steel with polyester finish.
  - 2. Discharge Grille: Punched-louver discharge grille allowing four-way discharge-air pattern.
  - 3. Louvers: Extruded aluminum with enamel finish; white color.
  - 4. Finish: Epoxy coating.
  - 5. Access Door: Hinged door in top of cabinet for access to controls.
  - 6. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
- C. Refrigeration System: Direct-expansion indoor coil with capillary restrictor; and hermetically sealed scroll compressor with vibration isolation and overload protection:
  - 1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins.
  - 2. System to include an accumulator, constant-pressure expansion valve and refrigerant charge of R-410A.
- D. Condensate Drain: Drain pan to direct condensate to piped discharge:
  - 1. Comply with ASHRAE 62.1 for drain pan construction and connections.
- E. Control Module: Remote-mounted digital panel with touchpad programmable temperature control.
- F. Unit Performance Ratings: Factory test to comply with ARI 310/380.
- G. See schedule on drawings for additional information.

## **2.02 EXTERNALLY MOUNTED PACKAGED TERMINAL AIR CONDITIONING, (PTAC-2, 3)**

- A. Description: Factory-assembled and -tested, self-contained, packaged terminal air conditioner. Externally wall mounted. To comply with minimum efficiency requirements of ASHRAE 90.1.
- B. Cabinet: 0.052-inch thick steel with removable front panel with concealed latches:
  - 1. Mounting: Full length mounting bracket for external mounting.
  - 2. Finish: Zinc coated.
  - 3. Slope top with top rain flashing
- C. Refrigeration System:
  - 1. Coils: Seamless copper tubes mechanically expanded into aluminum fins.
  - 2. Scroll compressors.
  - 3. R-410a
- D. Control Module:
  - 1. Wall mounted temperature control with temperature output signal to SCADA system.
  - 2. Compressor: Built-in off-delay timer adjustable from 30-seconds to 5-minutes. 2-minute on-delay if power interrupt. 120-second bypass for low pressure control, and both soft and manual lockouts for high- and low-pressure controls. Alarm output for alarm relay to SCADA system.
  - 3. Pressure Switches: Built-in lockout circuit resets from room thermostat.
  - 4. Economizer:
    - a. Internally mounted to allow outdoor air to be introduced through air inlet openings.
    - b. Built-in exhaust air control damper.
    - c. Built-in intake control damper with controls to limit amount of outdoor air in response to system controls and settings defined by end user:
      - 1) Single blade design.
      - 2) Positive shut-off with non-stick gaskets.
    - d. Intake hood to deliver up to 100 percent of cooling rated airflow.
    - e. Outside air filter sleeve.
  - 5. Lead/Lag Operation:
    - a. Two units shall operate in lead/lag fashion.
    - b. Lead unit shall run first.

- c. On failure of lead unit, lag unit shall run, and lead unit shall turn off.
  - d. If space setpoint has not been reached within 20-minutes (adj.), lag unit shall stage on and run in unison with lead unit to maintain space temperature setpoint.
  - e. Designated lead unit shall rotate upon one of the following conditions (user selectable):
    - 1) Manually through software switch.
    - 2) If pump runtime (adj.) is exceeded.
    - 3) Daily.
    - 4) Weekly.
    - 5) Monthly.
- E. Unit Performance Ratings: Factory test to comply with ARI 310/380.
- F. See schedule on drawings for additional information.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install units' level and plumb, maintaining manufacturer's recommended clearances and tolerances.
- B. Install wall sleeves in finished wall assembly; seal and weatherproof.
- C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

### **3.02 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 2. After installing packaged terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Packaged terminal air conditioners will be considered defective if they do not pass tests and inspections.

### **3.03 STARTUP SERVICE**

- A. Perform startup service.
- B. After installation, verify the following:
  1. Unit is level on base and is flashed in exterior wall.
  2. Unit casing has no visible damage.
  3. Compressor, air-cooled condenser coil, and fans have no visible damage.
  4. Labels are clearly visible.
  5. Controls are connected and operable.
  6. Shipping bolts, blocks, and tie-down straps are removed.
  7. Filters are installed and clean.
  8. Drain pan and drain line are installed correctly.
  9. Electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 – Sections.
  10. Installation. Perform startup checks according to manufacturer's written instructions, including the following:
    - a. Lubricate bearings on fan.
    - b. Check fan-wheel rotation for correct direction without vibration and binding.
- C. After startup service and performance test, change filters.

**END OF SECTION**

**SECTION 23 82 39**  
**ELECTRIC HEAT UNITS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in lump sum prices offered in the Price Schedules for Heating, Ventilating and Air-Conditioning (HVAC) System.

**1.02 REFERENCE STANDARDS**

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 62.1-2019                      Ventilation for Acceptable Indoor Air Quality

**1.03 SUBMITTALS**

A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.

B. RSN 23 82 39-1, Approval Data and Drawings:

1. Manufacturer's product data indicating:
  - a. Heating capacity.
  - b. Throw distance.
  - c. Dimensions.
  - d. Materials of construction.
  - e. Weights.
  - f. Electrical requirements with electrical characteristics and connection requirements.
  - g. Controls.
  - h. Accessories.
  - i. Include submittal requirements of section 23 05 13 – Common Motor Requirements for HVAC Equipment.

C. RSN 23 82 39-3, Final Data and Drawings:

1. Operation and Maintenance Data. Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.
2. Bound copy of signed, stamped, previously approved data.

#### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

#### **1.05 COORDINATION**

- A. Coordinate installation with building structure.

### **PART 2 PRODUCTS**

#### **2.01 PROPELLER UNIT HEATERS**

- A. Description: An assembly including casing, coil, fan, and motor in with adjustable, vertical discharge configuration louvers.
- B. Cabinet: Removable panels for maintenance access to controls.
- C. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and tested propeller unit heater before shipping.
- D. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- E. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-hertz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16-inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 degrees F at any point during normal operation:
  - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
  - 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.
- F. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in fan venturi.
- G. Wall mounting bracket.
- H. Control Devices:
  - 1. Wall-Mounted on-off PID thermostat.
  - 2. Non-fused disconnect switch and a 24 VAC Class II transformer/relay package.
- I. See schedule on drawings for additional requirements.

**PART 3 EXECUTION****3.01 EXAMINATION**

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.02 INSTALLATION**

- A. Install propeller unit heaters level and plumb.
- B. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers.

**3.03 CLEANING**

- A. Vacuum clean coils and inside of unit cabinet.

**END OF SECTION**

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**SECTION 25 00 01**  
**SYSTEM CONTROL AND MONITORING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. System Control and Monitoring:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI - ISO/IEC 9797-2011 Information Technology - Security Techniques Message Authentication Codes

B. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 802.3-2012 Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection Access Method and Physical Layer Specifications
2. IEEE 1100-2005 Recommended Practice for Powering and Grounding Electrical Equipment
3. IEEE 1815-2015 Electric Power Systems Communications – Distributed Network Protocol (DNP3)
4. IEEE C2-2017 National Electric Safety Code (NESC)
5. IEEE C37.90.2-2004 Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
6. IEEE C62.41.1-2008 Guide on the Surge Environment in Low-Voltage (1,000 V and Less) AC Power Circuits
7. IEEE C62.42-2005 Guide for the Application of Component Surge – Protective Devices for Use in Low-Voltage [Equal to or Less than 1,000 V (ac) or 1,200 V (dc)] Circuits
8. IEEE C62.43-2005 Guide for the Application of Surge Protectors Used in Low-Voltage (Equal to or Less than 1,000 Vrms or 1,200 Vdc) Data, Communications, and Signaling Circuits

9. IEEE C62.72 Guide for the Application of Surge-Protective Devices for Low-Voltage (1,000 V or Less) AC Power Circuits
- C. Electrotechnical Commission (IEC)
1. IEC 61131-3-2013 Programmable Controllers – Part 3: Programming Languages
- D. International Organization for Standardization (ISO)
1. ISO/IEC 13817-1 Information Technology - Programming Languages, Their Environments and System Software Interface
- E. International Society of Automation (ISA)
1. ISA 101.01-2015 Human Machine Interfaces for Process Automation Systems
2. ISA 62443-1-1(99.01.01)-2007 Security for Industrial Automation and Control Systems Part 1-1: Terminology, Concepts, and Models
3. ISA 62443-2-1(99.02.01)-2009 Security for Industrial Automation and Control Systems Part 2-1: Establishing an Industrial Automation and Control Systems Security Program
- F. National Electrical Manufacturers Association (NEMA)
1. NEMA 250 - 2014 Enclosures for Electrical Equipment (1,000-Volts Maximum)
2. NEMA FU 1 - 2012 Low Voltage Cartridge Fuse
3. NEMA ICS 1-00 (R2015) Industrial Control and Systems: General Requirements
4. NEMA WC 70 - 2009 Non-shielded Power Cables Rated 2,000-Volts or Less for the Distribution of Electrical Energy
- G. National Fire Protection Association, Inc. (NFPA)
1. NFPA 70-2017 National Electrical Code (NEC)
- H. National Institute of Standards and Technology (NIST)
1. NIST SP 800-53 Rev4 Security and Privacy Controls for Federal Information Systems and Organizations
2. NIST SP 800-82 Rev2 Guide to Industrial Control Systems (ICS) Security

- I. Underwriters Laboratories, Inc. (UL)
  - 1. UL 508-1999 Industrial Control Equipment, Seventeenth Edition

### **1.03 DEFINITIONS AND ACRONYMS**

- A. FIT: Flow Indicating Transmitter.
- B. HMI: Human Machine Interface.
- C. HART: Highway Addressable Remote Transducer.
- D. I/O: Input/Output.
- E. LCD: Liquid Crystal Display.
- F. LED: Light-Emitting Diode.
- G. NTUA: Navajo Tribal Utility Authority.
- H. NGWSP: Navajo-Gallup Water Supply Project.
- I. OIT: Operator Interface Terminal.
- J. PAC: Programmable Automation Controller.
- K. PI: Proportional Integral.
- L. PID: Proportional Integral Derivative.
- M. PLC: Programmable Logic Controller.
- N. PoE: Power-over-Ethernet.
- O. RTD: Resistance Temperature Detector.
- P. RTU: Remote Terminal Unit.
- Q. SCADA: Supervisory Control and Data Acquisition.
- R. SFP: Small Form-Factor Pluggable.
- S. UPS: Uninterruptible Power Supply.
- T. VPN: Virtual Private Network
- U. Facility Systems:
  - 1. Pumping plant, tank control, HVAC control, Chlorine injection, Communications and security systems, and all necessary systems for complete SCADA operation of Pumping Plant.

## 1.04 SUBMITTALS

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. Drawings and data in sufficient detail to show full compliance with this specification and applicable codes.
- C. RSN 25 00 01-1, Approval Data - Monitoring and Control Systems Technical Specialist Work Summary:
  - 1. Include description of previously completed similar projects.
- D. RSN 25 00 01-2, Design Coordination Meeting and Conference Call Records:
  - 1. Meeting schedules and agendas, to include:
    - a. List of invitees,
    - b. Location of meeting,
    - c. Topics to be discussed,
    - d. Excepted outcomes,
  - 2. Meeting minutes, to include:
    - a. Attendee list,
    - b. Action items, identifying responsible party and actions to be taken,
    - c. Decisions and agreements
- E. RSN 25 00 01-3, Component Data:
  - 1. Component Data:
    - a. Manufacturer's technical data and catalog sheets on proposed system components.
    - b. Identification of model or catalog number proposed, equipment capabilities, and electrical characteristics.
- F. RSN 25 00 01-4, System Architecture:
  - 1. System architecture drawing, including communications links, showing major components, including, but not limited to servers, network switches, and media converters.
- G. RSN 25 00 01-5, System Description Documentation:
  - 1. Functional System Description:
    - a. Describe and document the proposed SCADA system, its features and limitations, compliance with the requirements, operation, software algorithms, display screens, and software configuration.

2. System overview:
    - a. System overview shall provide a general understanding of hardware, software, control functions, interfaces, and general data flow associated with entire system. System overview document shall include software block diagram of entire system.
  3. System database structure.
- H. RSN 25 00 01-6, Approval Drawings and Data:
1. Drawings in “Government format”:
    - a. Networking diagram.
    - b. Instrumentation loop, schematic, and wiring diagrams.
    - c. Design analysis and calculations of equipment power consumption at master- station.
  2. Bill of Materials.
- I. RSN 25 00 01-7, Approval Data - Software Development Documentation:
1. I/O List, including at a minimum the following information:
    - a. Point designation.
    - b. I/O Component location.
    - c. Type and rating information.
    - d. Termination data.
  2. Datapoints List, including the following minimum information:
    - a. Includes information on logical and calculated datapoints, as well as datapoints that are communicated between components.
    - b. Provides datapoint tag or identifier information as well as a descriptive name of the datapoint.
  3. Master Alarm List, including the minimum following information for each alarm:
    - a. Alarm Identifier.
    - b. Alarm setpoints.
  4. Data flow chart including all variables.
  5. Graphic display drawings (proposed LCD display and OIT touch panel) for each screen provided as part of OIT.
  6. OIT graphical screenshots.
  7. Logic diagrams: Functional and binary logic drawings for the entire SCADA System.
  8. Plant SCADA software, including OIT, Alarm and Events, and Web Server applications.

- J. RSN 25 00 01-8, Layout Drawings:
1. Dimensioned drawings showing relative positions of components. Includes component identification and layout information.
  2. Enclosure and Control Panel Layout Drawings, drawings for enclosures and control panels:
    - a. Exterior and interior arrangements.
  3. Master station layout drawings, including layout of all rack mount equipment and components.
  4. Include nameplate information.
- K. RSN 25 00 01-9, Check Prints:
1. Instrumentation loop, schematic and wiring diagrams.
- L. RSN 25 00 01-10, Approval Data - Final Drawings and Documentation:
1. Include:
    - a. Final drawings of all approved layouts, schematic diagrams, and wiring diagrams including “as-built” changes.
    - b. Final version of approved software documentation including “as-built” changes.
    - c. Updated I/O Points Lists in Section 51 00 20 – I/O Points List with information for “Data Point Identifier” and “Data Point Address” columns. Hand-written entries are not acceptable. Government will provide “editable” version of these lists for which Contractor will type in required information.
    - d. Spare parts list.
- M. RSN 25 00 01-11, Operation and Maintenance Instruction Books:
1. Operation Manuals:
    - a. Intended for use in operating the system.
    - b. Describe operation in a manner and a level of detail sufficient to detect and isolate problems.
      - 1) Do not include descriptions of procedures not performed by operators, such as program modifications.
    - c. Include operation of following system features and hardware items:
      - 1) Screen displays and control operations.
      - 2) General description of all control actions.
      - 3) Limit and trend settings.
      - 4) Manual status entry.
      - 5) Report generation.
      - 6) Control access methods.

- d. Include description of how to perform “manual operation” of system without use of PAC, PLC or OIT.
2. Programmer's Maintenance Manuals:
- a. Describe system software structure and each software functional task of the system.
  - b. Summarize interrelationships of functional tasks including those of operating system related to software.
  - c. Written at an experienced programmer's level:
    - 1) Use for reference and training of Government personnel.
  - d. Furnish narrative description for each program: Indicate:
    - 1) Inputs.
    - 2) Outputs.
    - 3) Timing considerations with runtime and memory size estimates.
    - 4) Tentative priority assignments.
    - 5) Residency requirements.
    - 6) Other operating characteristics.
  - e. System database: Describe with functional description of each element and its usage by each program.
  - f. Contains the following for application programs:
    - 1) Descriptive comments.
    - 2) Flow charts.
    - 3) Detailed source listings in addition to removable storage media.
  - g. Vendor Manuals:
    - 1) Documentation published by vendors in support of vendor supplied hardware/software incorporated into system.
    - 2) Include:
      - a) Detailed level of maintenance.
      - b) Theory of operation.
      - c) Illustrated parts.
      - d) Installation.
      - e) Operating and test instructions.
    - 3) Software vendor manuals. Include:
      - a) Reference manuals for interactive text editors.
      - b) Language compilers.

- c) Macro/micro assemblers.
  - d) Debuggers.
  - e) Record manager.
  - f) System generation.
  - g) Diagnostic programs.
  - h) Sort/merge utilities.
  - i) Loaders.
  - j) Real-time operating system.
- 4) Obtain permission from vendors to permit Government to reproduce documents.

## 1.05 QUALIFICATIONS

- A. System Integrator: No less than 10-years of experience designing SCADA systems for pumping plants. No less than 3 prior projects using PLCs, same type and model, supplied for this project. PLC experience may include prior projects using an earlier PLC model from the same product line. Experience shall include development of control logic, programming and development of graphic displays.
- B. Installer: No less than 10-years of experience installing SCADA systems with a variety of components including PLCs.
- C. Training Staff:
- 1. Competent with and knowledge of specific equipment that training is provided for, and material presented:
    - a. Minimum 5-years of experience on equipment of similar type and function as equipment supplied for this project.
    - b. Minimum 2-years of experience on specific type and models of equipment.
  - 2. Fluent in English.
  - 3. Instructor qualifications subject to review and approval by COR.

## 1.06 SYSTEM DESCRIPTION

- A. Provide a SCADA System for the following facilities and locations:
- 1. Pumping Plants No. 4 and No. 7, see drawing 1695-D-60527.
- B. SCADA System shall be the primary control, automation, and monitoring system for pumps, butterfly valves, tank levels, instruments, chlorination system (Pumping Plant No. 4 only), and security and surveillance system of each facility:

1. Perform configuration and programming activities required for a complete and functional system.
2. Provide operator interface, control processing, and I/O processing.
3. Provide graphic displays viewable from OITs. Graphic displays shall be developed to cover the systems and components controllable from the SCADA system and shall include sub-displays as required in this Section. Graphic displays shall show status of all components and system processes tied into control and monitoring system.
4. Fully integrated system, including the following minimum features:
  - a. Processing units, I/O components, network and communication components, power supplies and other miscellaneous control components.
5. Provide latest hardware and software offered by respective manufacturers at time of award.
6. Include:
  - a. Control, data, and monitoring identified in these Specifications.
  - b. Control, data, and monitoring to render a complete, and functional, system which meets, at minimum, functional intent and requirements stated herein and provides safe and reliable operation of site equipment and components under all conditions.
7. At minimum all I/O identified in Section 51 00 20 – I/O Points List and the Piping and Instrumentation Diagram (P&ID) shown in drawings Pumping Plant No. 4 1695-D-60507 through 1695-D-60515 and Pumping Plant No. 7 1695-D-60516 through 1695-D-60521.
8. An NTUA provided optical fiber transmission system shall be primary means of long-haul communications networking between pumping plants and remainder of San Juan Lateral features. This optical fiber transmission system consists of an aerial cable (provided by Others) routed along NTUA's 25kV distribution power line:
  - a. Utilize the following components for connection to optical fiber transmission line:
    - 1) Fiber bypass unit for connection to optical fiber transmission line to ensure network integrity upon a power outage at the WTP from impacting connectivity along optical fiber transmission line.
    - 2) Network Gateway switch as a firewall between pumping plant local SCADA and Business network switches, as shown in drawing 1695-D-60527, and the NTUA long-haul communication network.
  - b. Primary communication system utilized for transmission of the following signals:
    - 1) SCADA/Control Data:

- a) Transmission of SCADA/Control Data shall utilize DNP3 communication protocol.
      - 2) Voice over Internet Protocol (VOIP) telephone signals.
      - 3) Security system signals.
    - c. Utilize IPsec VPN tunnels for transmission of SCADA/Control data with remote facilities.
  9. Provide interface for a backup radio communication system to be provided by others in the future. Interface to future radio system shall support DNP3 communication protocol:
    - a. Backup communication system utilized for transmission of the following signals:
      - 1) SCADA/Control Data (backup communication path).
    - b. Provide connection point into facility SCADA system network for future connection to a radio system.
    - c. Provide space on site for installation of a radio tower (by others). Location for radio tower installation shall be relatively flat and include a minimum 20-foot x 20-foot clear area.
  10. Interface with systems and control components through either hardwired I/O signals or datalinks:
    - a. PLC's shall communicate with the facility's systems via Modbus RTU or Modbus TCP when available through those systems or controllers.
- C. All software, including graphics and control logic implementations shall be configurable by Government to allow for future modifications to SCADA System:
1. Graphic display configuration software shall include libraries of standard displays, nameplates, and components utilized by Government for future SCADA System modifications
  2. Modules used in control logic implementation shall be viewable and configurable by Government, including internal implementation of those modules.
- D. Password protect access to PLC program loading. Provide the following access levels in the software:
1. Status access:
    - a. View only access to all plant displays and trends.
    - b. No access to process control or alarm acknowledgment.
  2. Operator access:
    - a. Access to all plant displays, trends, process control and alarm acknowledgement.

3. Administrator:
  - a. Access to all plant displays, trends, process control and alarm acknowledgement.
  - b. Access to view and modify SCADA software.
- E. System control and monitoring system shall meet cybersecurity requirements articulated in ISA 62443-1-1, ISA 62443-2-1, NIST SP 800-53 Rev4, and NIST SP 800-82 Rev2.
- F. Utilize off-the-shelf system components and software packages.
- G. I/O components, communication components, backplanes, and other components, utilized in the SCADA System shall be of the same manufacturer. Minimize number of different types and models utilized.
- H. Provide system software and components not mentioned specifically but essential for system to meet functional requirements of these Specifications.

#### **1.07 DESIGN REQUIREMENTS**

- A. Develop system architecture, arrangement and layout of system components.
- B. Develop detailed software based on process control drawings, these specifications, and design coordination meetings to make fully functional water supply system.
- C. Develop I/O point lists, alarm points lists, data-point lists, and memory allocation for data-points. Refer to Section 51 00 20 – I/O Point List as initial information from which to develop final I/O point lists, alarm points list and, data-point lists. Contractor shall complete system design.
- D. Provide SCADA System programming, control logic and macros:
  1. Includes development of logic diagrams, flow charts, and OIT displays.
  2. Provided documentation and descriptions listed within software, including descriptions for each rung, block, or line of ladder diagrams, function block diagrams, and structured text logic.
- E. Provide interface design:
  1. Include development of schematics, datalinks, and other applicable items, required for interfaces between components.
- F. Design components of SCADA System referenced in this Section.
- G. Provide configuration and programming of SCADA System components.
- H. Select system hardware and software to provide a virtualization environment as much as possible.

- I. Furnish Ethernet communications, TCP/IP for interconnectivity of multiple systems from different suppliers.
- J. Electronics, shall be immune from false operation, false logic signals, or failure from voltage and frequency transients, and radio frequency interference which may be conducted in control circuitry and power supplies:
  - 1. Take special precautions to limit exposure of sensitive electronic circuits connected to remote equipment.
  - 2. Design system to meet requirements, guidelines and recommendations of IEEE 1100, IEEE C62.41.1, IEEE C62.42, IEEE C62.43, and IEEE C62.72.
- K. Determine size and ratings of the following:
  - 1. Fuses.
  - 2. Power supplies.
  - 3. Surge suppression devices.
  - 4. Uninterruptable Power Supply (UPS).

#### **1.08 DESIGN COORDINATION MEETINGS**

- A. Conduct a minimum of three design coordination meetings with both Contractor and Government in attendance:
  - 1. Two design coordination meetings will be held at Governments facilities in Farmington, NM or mutually agreed upon location.
  - 2. One design coordination meeting will be held at construction site or mutually agreed upon location.
  - 3. Sub meeting notifications in accordance with RSN 01 31 19-1, Pre-Design Electrical Coordination Meeting Notifications.
- B. Conduct monthly design coordination conference calls with both Contractor and Government in attendance.
- C. Purpose of meetings will be to discuss coordination issues, programming and control logic algorithms, specific details of plant operation, report generation, and graphic display configurations.
- D. Design coordination meetings shall be scheduled at mutually agreed upon date and time.
- E. Contractor is responsible for providing all equipment and paperwork needed for review and discussion of design coordination subjects.
- F. Any additional meetings shall be mutually agreed upon.

## **1.09 EXTRA MATERIALS**

- A. Furnish a set of special tools and accessories required for installation, normal operation, and maintenance for each facility. Include:
1. Contractor and manufacturer recommended tools and accessories.
  2. Tools and accessories recommended for field maintenance and those designed to aid in the diagnosis, maintenance, repair and replacement of supplied equipment.
- B. Furnish spare parts. Furnish a set of the following components for each facility:
1. I/O Cards: Minimum of 5 percent spare of each type used at the facility, no less than one (1) of each size and type used at each facility.
  2. Network and Communication Cards or Components: Minimum of one (1) spare of each type of control system component.
  3. Programmable Controllers: Fully redundant spare set of automation controllers. Sufficient quantity of each type to allow swap out of each unit's automation controllers located at the facility. Redundant set of automation controllers shall be preprogrammed to allow quick replacement of installed facility controllers in the event of a failure.
  4. Back planes: Minimum of one (1) spare of each type of control system component.
  5. Communications Converters: Minimum of one (1) spare of each type of communications converter used.
  6. Miscellaneous Components: Minimum of one (1) spare of each type of control system component.
  7. HMI: One spare of each type.
  8. Contractor or manufacturer recommended spare parts.
  9. Replace spare parts used during the installation, testing, and commissioning process to provide a complete set of spare parts at each facility.
- C. Furnish two copies of system software. Include:
1. Software required to re-install software required for the system to function properly, for each facility.
  2. Copies supplied shall contain the final version of all furnished software.

## **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store all hardware in accordance with manufacturer's instructions. Include copy of instructions with equipment at time of shipment.

## **PART 2 PRODUCTS**

### **2.01 OPERATOR INTERFACE TERMINAL (OIT)**

- A. OIT(s) shall perform as primary HMI to SCADA system:
1. Provide a minimum of one OIT per Plant Control/SCADA Equipment Cabinet located in the Control Room of each Pumping Plant Building.
  2. Color TFT LCD, WVGA. 15-inch display, minimum.
  3. Touch Screen.
  4. Modbus TCP/IP, RS485, RS232.
  5. Vijeo Designer Development Tools, Magelis OS.

### **2.02 PROGRAMMABLE LOGIC CONTROLLER**

- A. Modicon M580 Programmable Controller including accessories shall meet the following requirements:
1. Din rail:
    - a. Chassis.
    - b. 24 VDC Power Supply.
  2. Ethernet capable.
  3. Provide with a minimum of 40 percent spare capacity, including memory utilization, processing capacity, and other functions.
- B. Remote Programmable Controller for Turnout Building ruggedized for outside atmospheric conditions.
- C. Remote Programmable Controller for Chemical building, Pumping Plant No. 4 only, ruggedized for outside atmospheric conditions.

### **2.03 INPUT/OUTPUT (I/O)**

- A. Provide I/O as required to meet specified functionality.
- B. Provide I/O cards intended for use with the Modicon M580 product line, manufactured by Schneider Electric <http://www.schneider-electric.com>.
- C. Provide 10 percent spare installed I/O of each size and type at each I/O location.
- D. Provide capability to install 20 percent additional future I/O cards at each I/O location. Includes connection capability, space on backplanes and sufficient margin in power and operating capacity for a true 'plug and play' installation of additional I/O cards.

## **2.04 PROGRAMMING CONTROL LOGIC**

- A. Provide capability of programming control logic in Control System using the following programming languages, in accordance with IEC 61131-3:
  - 1. Ladder Diagram.
  - 2. Function Block Diagram.
  - 3. Structured Text.
- B. Implement majority of control logic in SCADA System using Ladder Diagram or Function Block Diagram, with only select areas implemented using other methods if necessary.
- C. Emphasize readability and maintainability in control logic implementation.
- D. Fully document all control logic developed for each facility.

## **2.05 GRAPHIC DISPLAYS**

- A. Provide graphic displays for SCADA Systems in accordance with requirements and recommendations in ISA 101.01. ISA 101.01 recommendation and requirement in addition to requirements included in this Specification represent minimum level of functionality for graphic displays.
- B. OIT software: As required.
- C. SCADA System graphic displays are subject to approval by COR.
- D. Spare capacity for an increase of up to 20 percent in the number of graphic pages.
- E. Designed to support user situational awareness, intuitive navigation, and intuitive system status and condition information.
- F. Designed to support all types of tasks and activities required of the operator. Control of system and modification of operational setpoints shall normally be accomplished through OIT.
- G. Separate graphic display screens shall be designed and provided for screens with different functions and locations.
- H. Use consistent design philosophy across graphic displays, however the specific functions desired for the individual screens may require unique arrangements of graphics and information.
- I. SCADA System graphic displays shall incorporate a hierarchy of displays that provide a progressive exposure to detail. The following list provides a general guideline for the hierarchy of displays:

1. Highest level display shall show entire system within operator's control. This display is intended to act as an overall indicator as to how the site is running, by tracking key performance indicators.
  2. SCADA System display.
  3. Displays shall consist of detail information on system operations.
- J. User interaction techniques shall be developed in accordance with the following guidelines:
1. Clear, with graphics that are consistent in the method that they present similar information.
  2. Graphic functions: Standardized, intuitive, straight forward with minimal user manipulation.
  3. Error tolerance in user interaction for critical devices shall be included, with simple notification of error and effective methods for recovery.
- K. Develop a color scheme for graphic displays for approval by COR:
1. Grey backgrounds for graphics, with minimal use of color in graphics.
  2. Utilize color very specifically and consistently.
  3. Color alone shall not be the sole differentiator of an important condition or status.
- L. Include analog representation of important measurements, indicating their value relative to normal, abnormal and alarm conditions.
- M. Include visual indication if an Operator input field, or other operator initiated control function, has been disabled.
- N. Response time requirements for the graphic displays:
1. Graphic displays shall take no longer than 3-5 seconds to appear when called up.
  2. Update live information on display every 2-seconds unless critical nature of process information displayed requires more frequent updating.
- O. Provide feedback on the completion of an action and/or of the failure to complete an action.
- P. Component Depiction:
1. Utilize standard shapes for components. Shapes should be simple and avoid unnecessary detail.
  2. Show status of components clearly and consistently.
  3. Include operating hours on operating and standby rotating equipment.
  4. Provide faceplates to display detailed component information and user input fields.

5. Vessels and Tanks:
    - a. Size shown shall be relative to process importance of component and relate to its physical size.
  6. Process Lines: Limited number of line types and line thickness.
  7. Process Controllers:
    - a. Depicted as a physical entity on the graphics, with key values like set point, output, and control mode displayed. Provide faceplate type displays for process controllers with detailed information and user input fields, where required, for the process controller.
- Q. Text and Values:
1. Do not display leading zeros when depicting values unless the value is less than 1.
  2. Differentiate live values from static text, for example by depicting live values with a color. Units of measure should not be depicted as a live value.
  3. Date and time display:
    - a. Display date in form of “YYYY-MM-DD” on every format.
    - b. Display time of day in form “hours:minutes:seconds” on every format. Update time display automatically once every second.
  4. Page title: Each format shall have appropriate page title.
- R. Provide visual display of lockout/tagout application.
- S. Provide faceplates for sequences, including automatic startup and shutdown.
- T. Annunciate all active trip conditions on the graphic.
- U. Alarms:
1. Alarms and indications of abnormal situations shall be clear, prominent, and consistently distinguishable.
  2. Provide the following minimum alarm displays:
    - a. Alarm status.
    - b. Alarm log.
  3. Displays shall provide the Operator the ability to:
    - a. Acknowledge alarms.
  4. Place alarms out of service (access-controlled operation).
  5. Modify alarm attributes (access-controlled operation).
  6. Alarm indication in the SCADA System shall have audible alarms associated with them:
    - a. Sound level of the alarm shall be enough for easy detection.

- V. No animation except for specific alarm related graphics.
- W. Alarm and Events:
  - 1. Maintain a consistent approach to alarming across the entire system.
  - 2. Allow for alarm monitoring for all discrete and analog inputs/outputs and communication links.
  - 3. Document the following for each alarm:
    - a. Alarm type.
    - b. Alarm setpoint.
  - 4. Indicate acknowledged alarms, unacknowledged alarms, and unacknowledged alarms which have returned to normal.
  - 5. Time stamped logs for alarm history, event history, diagnostic, and audit history for the alarm system.

## **2.06 DIAGNOSTICS**

- A. SCADA System components shall contain self-diagnostic programs to identify component degradation, malfunction, failure, and faults.
- B. Provide documentation and feedback on potential causes of alarms related to operation of internal system components, to be used to support trouble shooting of system components.

## **2.07 CONTROL**

- A. Designed to aid operator over complete operating range of the facility while controlled equipment is in service. Available and configurable parameters usable to control equipment within manufacturer's limitations and enhance equipment life shall be incorporated into the system design.
- B. Include a system of interlocks to:
  - 1. Prevent improper and hazardous actions of the control system.
  - 2. Provide maximum flexibility of system operation, maintenance, testing, and calibration while providing safe operating conditions.
- C. Provide modifiable setpoints and control variables, including alarm setpoints, delays, and control setpoints that are modifiable by operator at OIT. Sufficient setpoints shall be included to allow operator adjustment of system through desired operating range. All values referred to as 'setpoints' in these Specifications shall be modifiable from OIT.

- D. Provide logic to minimize the requirement for operator intervention:
1. Designed to incorporate permissives, which ensure that prerequisite conditions for safe operation are met prior to allowing equipment to start, open, or close, as appropriate.
  2. Incorporate interlocks to prevent equipment from operating in unsafe or potentially damaging conditions.
- E. Grouped Control Logic:
1. Provided where multiple components are required to operate in a prescribed combination or sequence.
  2. Start or stop motors and open or close valves in a predetermined sequence without requiring operator action during the process.
- F. Provide control logic to mitigate bad quality or out of range signals. Logic shall drive devices to a safe state, substitute a value, or hold last value as appropriate for application.
- G. Fault checking shall be included and cause appropriate response, change over and/or alarm.
- H. Upon initial system power up, or system power restoration, all systems shall be in manual with outputs in “off” or fail-safe mode.
- I. Provides rapid shut down and emergency shutdown of equipment.
- J. Make appropriate adjustments to SCADA systems for areas where actual Contractor supplied equipment and installation varies from the information included in Contract Documents.
- K. Monitoring and Alarming:
1. Where monitoring or alarming are required in these Specifications at a minimum provide the following functionality. This does not preclude additional functionality required by other requirements in these Specifications or required system functionality.
  2. Monitoring
    - a. Display information received from end devices on graphic displays. Display information in units of process measurement where applicable.
    - b. Where Flow Indicator Transmitter (FIT) devices are shown on Piping and Instrumentation Diagram display the following minimum information on graphic displays:
      - 1) Flow Direction.
      - 2) Flow.
      - 3) Total Flow.

3. Alarming:
  - a. Provide for levels that would indicate pre-trip and trip conditions in the process system, i.e. include Low, Low-Low, High, and High-High alarm conditions as applicable.
  
- L. Monitor and provide alarming for all instruments and devices shown interfacing with one of the PLC cabinets on the supplied Piping and Instrumentation Diagram drawings, Section 51 00 20 – I/O Point List and where the Specifications reference interfaces with PLCs or SCADA system:
  1. Status alarms for SCADA equipment malfunctions.
  
- M. Facility Operation:
  1. Operational logic should incorporate data-points and system inputs shown in Section 51 00 20 – I/O Point List and supplied Process and Instrumentation Diagrams.
  2. Additional Facility Monitoring:
    - a. Monitor smoke detectors.
    - b. Monitor security intrusion system.
    - c. Status alarms for UPS system(s).
    - d. Status alarms for SCADA equipment malfunctions.
  3. Chemical Sampling and Sodium Hypochlorite Feed System Operation (Pumping Plant No. 4 only):
    - a. Operate system as necessary to meet requirements in Section 46 33 00 – Sodium Hypochlorite Feed System and supplied Process and Instrumentation Diagrams.
  4. Turnout Building Valves:
    - a. Provide operator initiated close from HMI.
  5. Automatic Pumping Operation:
    - a. Develop pump operational logic. Refer to Section 51 00 25 – Pump Control and Sequencing Logic as notational information from which to develop final pump operational logic. Contractor shall complete system design.
    - b. Operate the pumping systems at each facility based on downstream system demand. This shall be via the downstream tank level and the pressure feedback signal from the outlet of the pumping plant. System will be primarily operated based on downstream tank level, however it shall operate in pressure control based on the local pressure feedback signal in the event that the level feedback signal is lost.
    - c. Downstream Tank for Pumping Plant No. 4 is Tank No. 1 at Pumping Plant No. 7.

- d. Downstream Tank for Pumping Plant No. 7 is Tank No. 1 at Tohlakai Pumping Plant.
- e. Provide software interlock with operator adjustable time delay to ensure that only one pump at a time can start, and that the startup sequence for one pump has complete before the next pump begins its startup sequence.
- f. Provide user adjustable interlock to determine number of pumps allowed to run.
- g. If running pump fails, or pump fails to start when called, call next pump in sequence.
- h. Startup and shutdown sequence and system interlocks require proper configuration of valves and any support equipment/systems for safe and proper operation, startup and shutdown of pumps and facility.
- i. Provide operator adjustable start and stop level set-points to be adjusted in elevation units for both upstream and downstream tanks.
- j. If downstream tank is below adjustable level set-point and upstream tank is above adjustable level, next pump in sequence shall be called to start.
- k. Limit number of motor starts per hour to maximum specified per pump motor manufacturer.
- l. Monitor motor run times and total number of starts for each motor.

N. Operation Procedure:

1. Normal/Auto Start-up:
  - a. Verify pump start interlocks are met.
  - b. Start Pump.
  - c. Soft Start bypass contactor ON.
  - d. Open valve 2 once pressure between pump discharge and valve meets minimum threshold.
2. Normal/Auto Shutdown:
  - a. Close valve 2.
  - b. Valve 2 is full closed.
  - c. Stop Pump.

O. Remote System Interfaces

1. Provide the following remote-control signals for interface with the future San Juan Lateral SCADA System. Provide system programming, logic development and register address assignment so that all that is required to implement remote control interface is to complete the remote communication link. Interface will be via DNP3 communication over the optical fiber network connection:
  - a. Manual/Auto setting

- b. Automatic Operation Control Signals:
  - 1) Start Operation.
  - 2) Stop Operation.
  - 3) Change tank level operational setpoints.
- c. Manual Operation:
  - 1) Pump Start\Stop (each pump).
  - 2) Valve 2 Open\Close (each pump).
  - 3) Filling Valves Open\Close (Valves 4, 5 and 7 on Pump 4).
  - 4) Turnout Valve Close.
- 2. Contractor shall coordinate with BOR and San Juan Lateral SCADA system installer for setup of interface signals between the two systems.
- 3. Tohlakai Pumping Plant
  - a. Tohlakai Pumping Plant is connected to NTUA provided optical fiber transmission system that consists of an aerial cable routed along NTUA's 25kV distribution power line which will be connected through Pumping Plants No. 4 and No. 7.
  - b. Provide system interface and datalink to SCADA system at Tohlakai Pumping plant to Pumping Plant No. 7.
  - c. Datalink shall transmit datapoints required in these specifications.
  - d. Provide all activities and components, including installation, setup and modification activities required for both Pumping Plant No. 7 SCADA system and existing SCADA system at Tohlakai.
  - e. Provide a new SCADA network switch at Tohlakai for connection to the existing gateway switch:
    - 1) Network Router/Switch as a firewall between pumping plant local network and NTUA long-haul communication network.  
RUGGEDCOM RX 1510 network router and switch, or equal.
    - 2) Provide all cable, raceway, power supplies enclosures and other components required to install the new switch.
    - 3) Switch shall provide new interface point for the existing Tohlakai Pumping Plant SCADA System to the optical fiber transmission line.
  - f. Utilize an IPsec VPN tunnel for transmission of SCADA/Control Data with remote facilities.
- 4. Pumping Plant No. 3:
  - a. Contractor shall coordinate BOR and remote facility installers for setup of interface signals between Pumping Plant No. 4 and Pumping Plant No. 3.

- b. Datalink shall transmit datapoints required in these specifications.
- c. Provide all activities and components, including installation, setup and modification activities required for Pumping Plant No. 4 to implement this datalink.

P. Safety Measures:

- 1. Where PLC is utilized to control multiple systems of equipment, PLC components (I/O modules, power supplies, etc.) shall be assigned so that failure of any one component does not affect equipment on all systems.
- 2. Failure of any PLC, remote I/O hardware, or network communication link must be individually alarmed at OITs.
- 3. Watchdog function to monitor:
  - a. Internal processor clock failure.
  - b. Processor memory failure.
  - c. Loss of communication between processor and I/O modules.
  - d. Processor ceases to execute logic program.
- 4. Safety function wiring: Emergency shutdown switches shall not be wired into controller.
- 5. Initial safety conditions:
  - a. Utilize program module to dictate output states in known and safe manner prior to running of control program.
  - b. Utilize program each time PLC is re-initiated and control program activated.
- 6. Monitoring of internal faults and display:
  - a. Internal PLC system status and faults shall be monitored and displayed:
    - 1) Monitored items shall include:
      - a) Memory ok/loss of memory.
      - b) Processor ok/processor fault.
      - c) Scan time overrun.
- 7. Operator intervention:
  - a. Logic system failure shall not preclude proper operator intervention:
    - 1) Safety shutdown of equipment or system shall require manual operator intervention before equipment or system operation may be reestablished.

## 2.08 CONTROL MODES

### A. Automatic/Manual control:

1. These control modes shall be available for each component controlled by SCADA System.
2. Automatic:
  - a. Designed to eliminate the necessity for operator actions except for set point changes, biasing, and similar actions during normal operation.
  - b. If a component, or system, is incapable of full automatic operation, due to lack of electronic control interfaces with physical components, or operating concerns for a specific piece of equipment, the control shall be automated to the extent possible.
  - c. Includes automatic start/stop capability to automatically start and stop components, including proper sequencing of component operation to prevent damage or premature aging of the equipment.
3. Manual:
  - a. Allows operator to individually control each component controlled by the SCADA system.
4. Designed to provide bumpless transfer between automatic and manual operation without the need for operator action.

### B. Local/Remote control:

1. Apply facility wide. Provide a physical control switch located in proximity to the OITs to change control mode.
2. When in 'Local' control mode:
  - a. Operate facility from the local OITs.
  - b. Prevent control of the facility from the San Juan Lateral SCADA System.
3. When in 'Remote' control mode:
  - a. Operate facility from the San Juan Lateral SCADA System via interface with the facility SCADA system.
  - b. Prevent control from the local OITs, with the following exceptions:
    - 1) Local operators shall still be able to navigate through the graphic displays on the OITs, and display system indication and status information.
    - 2) Local operators shall be able to perform Lockout/Tagout operations.
4. Maintain operation of the facility in the event of a loss of the communication link to the San Juan Lateral SCADA System:

- a. If the communication link to the San Juan Lateral SCADA System is lost when the facility SCADA system is in 'Remote' mode, the facility SCADA system shall continue operating based on the dispatch information last received from San Juan Lateral SCADA System.
  - b. If communication link has not been re-established or control has not been reset to 'Local' mode within user adjustable set time duration, facility SCADA system shall transition facility to stop pumping.
5. Control system shall be designed to provide bumpless transfer between 'Local' and 'Remote' operation without need for operator action.

## **2.09 LOCKOUT/TAGOUT**

- A. Lockout/Tagout functionality shall provide the operator with the following minimum control features:
1. Ability to lockout all individual components.
  2. Ability to lockout process systems.
  3. Ability to lockout pump units.
- B. Upon application of a lockout/tagout command system shall automatically stop, or remove from service, affected component or system. This operation shall be performed regardless of control mode that system is in:
1. Lockout/Tagout functionality related to water chlorination (Pumping Plant No.4 only), and water tank mixer operation shall follow the following general guidelines:
    - a. Lockout/Tagout function in SCADA System shall not prevent operation of the devices required to regulate water chlorination (Pumping Plant No.4 only), and water tank mixer operation, from local control stations.
  2. SCADA System shall include logic to automatically react to the application of lockout/tagout on a component, or system, by making appropriate adjustments or shutting down impacted systems.

## **2.10 SECURITY**

- A. Develop a logical network topology that incorporates multilevel security zones, in accordance with the recommendations in ISA 62443-1-1, ISA 62443-2-1 and NIST SP 800-82. Provide the following minimum access control capabilities with the system:
1. Network segmentation via use of firewalls, routers, switches, etc. at appropriate locations.
  2. All firewall, or barrier device, locations shall be setup with the following characteristics:
    - a. Deny all communication by default and only allow communication by exception.

- b. Ports and services frequently used as attack vectors should not be opened through the firewall or barrier device. If a service, or function, is required and justified extra countermeasures shall be employed to compensate for the risk.
    - c. Only enable required ports and services through the firewall or barrier device.
  3. Throughput of security components, including firewall, etc., shall not limit performance of SCADA System.
- B. Access Control: Provide the following minimum access control capabilities, in accordance with recommendations in ISA 62443-1-1, ISA 62443-2-1 and NIST SP 800-82:
  1. Configurable account password solution to include requirements for password length, frequency of change, minimum required password complexity, number of login attempts, inactive session logout, screen lock by application, and denial of repeated or recycled use of the same password. Adjustments to these requirements shall only be with the explicit written approval of COR upon receipt of written justification.
  2. Network Components: Provide individual accounts for each user with customizable access privileges for each account. Accounts shall be configurable into role-based functions allowing varying levels of interface with and modifications to the system components. Include account authentication by approved method.
- C. Remove or disable all software components that are not required to provide specified system functions and capabilities or required for operation or maintenance of the system. This shall be performed prior to commissioning of components.
- D. Provide logging of all events, including access events for all network components. Where possible forward logs to central server for long term storage.
- E. Provide operating logs for windows operating systems.
- F. Provide approved anti-virus protection on components where applicable.

## **2.11 NETWORK**

- A. Provide high speed data network between automation controllers, processors, etc.:
  1. Network shall be designed to be scalable and facilitate future expansion of the system.
  2. Network design shall allow removal of any given component, including controllers, backplanes, communication cards, or I/O modules, associated with a given system partition without impacting communication to the other partitions:

- a. Specifically, taking out of service controllers, backplanes, communications cards, or I/O cards associated with a specific pump cannot impact the SCADA System communication to components associated with a different pump.
  3. Network shall be designed to facilitate speed of communication between networked components and shall not introduce significant data latency.
  4. Network shall be designed to have 50 percent spare base system capacity without exceeding performance limits.
  5. Provide optical fiber cable, in accordance with Section 26 05 10 – Conductors and Cables, for connections between network switches and other locations where required.
- B. Provide hardware, software, and design to provide fully functional bi-directional data links to other systems, components, PLCs, PACs, and networks as required.
- C. Control System shall provide support for the following minimum communication protocols:
1. DNP 3.0 per IEEE 1815.
  2. Modbus Serial (RTU and ASCII).
  3. Modbus Network (TCP).
  4. HART Communications Protocol.
- D. Provide capability for continual capture of netflow data between components for network and protocol analysis.
- E. Managed Industrial Network Switches see drawing 1695-D-60527.
1. Network Gateway Switch:
    - a. Provide network gateway switch as a security firewall between the pumping plant local network and NTUA long-haul communication network. Ciena Z series, model Z22 network switch, or equal.
  2. Business Network Switch:
    - a. Provide business network switch to connect Pumping Plant security and VoIP systems to network gateway switch. Cisco Catalyst 9300 series, model C9300-48P switch, or equal.
  3. SCADA Network Router/Switch:
    - a. Provide SCADA network router/switch as security firewall between pumping plant local network and NTUA long-haul communication network. RUGGEDCOM RX 1510 network router and switch, or equal.
    - b. Network Features:
      - 1) Layer 2 Ethernet switching.

- 2) Layer 3 IP routing.
    - a) SNMP and Web based management. Security Features:
    - b) Integrated stateful firewall.
    - c) SNMPv3 encrypted authentication and access security.
    - d) Multi-level passwords.
    - e) Supports IPSec Virtual Private Networking (VPN).
  4. All network switches shall provide the following minimum features:
    - a. Supports linear, star, and ring topology.
    - b. Loop Prevention.
    - c. Resiliency.
    - d. Segmentation.
    - e. Prioritization.
    - f. Time synchronization.
    - g. Security and Diagnostics
    - h. Provide ports and connections, as required. Spare to include, at a minimum the following:
      - 1) 20 percent spare ports of each type used at the switch.
  5. Physical Features:
    - a. Copper ports: Twelve 10/100BaseTX, RJ-45, minimum.
    - b. Fiber ports: Two 100BaseFX, single-mode 1310nm, ST connectors, minimum.
    - c. Status indicators on each port.
    - d. Power: Redundant inputs.
    - e. Enclosure: Metal case.
  6. Network Features:
    - a. IEEE 802.3 compliance.
    - b. IEEE 802.3af/at compliance.
    - c. Full/Half Duplex operation on all ports.
    - d. 100-Mbps throughput, minimum.
  7. Allows enabling/disabling ports.
  8. Provides 802.1Q VLAN segregation between predefined ports.
- F. Media Converters:
1. Industrial single mode fiber to Category 6 converter:

- a. Supports PoE over Category 6 cable with up to 30-watts per port.
- b. Power: 24 VDC input.
- c. Copper port: 10/100BaseTX, RJ-45, PoE, minimum.
- d. Fiber port: 100BaseFX, single-mode 1310nm.
- e. Operating temperature: -40 to 120 degrees F.
- f. Appropriate for use with installed system.

## **2.12 FIBER BYPASS UNIT**

- A. Provide an optical fiber bypass unit.
- B. Physical Features:
  1. Fiber ports:
    - a. Two channel 100BaseFX, single-mode 1310nm, ST connector, minimum.
  2. Power: Redundant 24 VDC inputs.
  3. Low power consumption.
  4. Optical Switching Time: 10 ms, maximum.
  5. Enclosure: Metal case.

## **2.13 PLANT CONTROL/SCADA EQUIPMENT CABINETS**

- A. Locations:
  1. As required for mounting system equipment and components/
  2. A cabinet shall be located in each Pumping Plant Building Electrical Room and, at a minimum, utilized for mounting the system OIT and related components.
  3. Provide adequate room for 180 degree opening of cabinet door.
  4. No less than 3- by 3-feet accessibility in front of cabinet.
- B. Enclosures design shall allow free and easy access to internal components.
- C. Type:
  1. Electrical Room: Floor Mounted.
  2. Other Enclosures: As required.
- D. Minimum NEMA 250 Type 1 or 12 enclosures for indoor installations and NEMA 250 Type 3R enclosures for outdoor installations.
- E. Size: As required to house components. All new enclosures shall include a minimum of 25 percent spare space.

- F. Constructed of sheet metal no lighter than 12-gauge.
- G. Seams continuously welded and ground smooth; no holes or knockouts.
- H. Continuous hinge on door. All doors shall be lockable.
- I. Finish:
  - 1. Manufacturer's standard coating.
- J. Back panel.
- K. Where required enclosures shall have louvers, or ventilation, as required to maintain temperature of equipment within manufacturer recommended range. Interior temperature shall be maintained at a minimum of at least 10 degrees F below maximum operating temperature of internal devices at maximum ambient temperature:
  - a. Fans or other forced ventilation devices shall be provided as redundant pairs and shall be provided with temperature alarms.
  - b. Louvers and openings shall be equipped with screens and changeable filter material to prevent the entrance of dust, insects and rodents.
- L. Provide thermostatically controlled cabinet space heaters to control condensation in all cabinets not in a temperature-controlled environment, or subject to condensation.
- M. Light kit.

## **2.14 COMMUNICATION RACK**

- A. 19-inch standard size.
- B. 42U minimum.
- C. Lockable.
- D. Mesh cooling design.
- E. Built-in utility outlets to plug into UPS.

## **2.15 INSTRUMENTS**

- A. RTD Type Ambient Temperature Sensors:
  - 1. Dwyer Series O-4, or equal, having the following essential characteristics:
    - a. Platinum type.
    - b. Ambient temperature sensor.
    - c. NEMA 4X enclosure.

2. Provide RTD type ambient temperature sensors to monitor ambient temperature inside each building.

## 2.16 POWER

- A. Provide power distribution system to all supplied components, including protection, to support full operation of the system. This distribution system shall include analog loop power supplies and contact interrogation voltages for dry contact inputs where required.
- B. Failure of any power supply, or power feed, shall be alarmed in the system.
- C. Provide all fuses, circuit breakers, power supplies, transformers etc., required to supply and transform power feeds at the desired voltage. Provide DIN Rail disconnect for each 120-volt circuit entering enclosure.
- D. At locations with UPS power systems the SCADA system components should be powered from that system.
- E. DC Power Supply:
  1. Type:
    - a. Switch-mode power supply.
    - b. Din-Rail mountable.
  2. Input Voltage: 100-240 VAC.
  3. Output Voltage: 24-VDC plus-and-minus 1 percent.
  4. Output Current: 5-Amps, minimum.
  5. Connection Type: Screw clamp.
  6. Operating Temperature Range: -20 to 60 degrees C.
- F. Uninterruptable Power Supply (UPS):
  1. Type: Tower.
  2. Minimum status display and outputs to SCADA System:
    - a. On line.
    - b. On battery.
    - c. Overload.
    - d. Replace battery.
  3. UPS trouble output to SCADA System.
  4. Input voltage: 120-volts, 60-hertz.
  5. Output voltage: 120-volts, 60-hertz.

6. Batteries:
    - a. Leak-proof.
    - b. Hot-swappable, user replaceable.
    - c. Maintenance-free sealed Lead-Acid battery with suspended electrolyte.
  7. Sized to provide at least 200 percent of full load current for all the following equipment inside SCADA cabinet and inside Network Cabinet for at least 30-minutes:
    - a. All SCADA system components, including PLCs, OITs, network and communication components.
    - b. All networking equipment.
    - c. All fiber equipment.
    - d. Security and Surveillance System.
    - e. Telephone System.
  8. Receptacle strip(s):
    - a. Provide adequate receptacles for each enclosure.
    - b. Voltage: 120-volts, 60-hertz.
    - c. Current: 20-amperes.
    - d. UL listed.
- G. Fuse Block and Fuses:
1. Type: Finger-Safe terminal block.
  2. DIN-Rail mountable.
  3. Fuse:
    - a. Rated for size required.
    - b. 250-volts, current limiting.
- H. Ground Bus:
1. Material: Copper.
  2. Size: Sufficient to attach equipment ground conductors.
  3. Length: Sufficient to attach equipment ground conductors plus 20 percent spare.
  4. Insulated mounting bracket.

## **2.17 INTERPOSING RELAYS**

- A. Type: General Purpose Relay.
- B. Double-Pole, Double-Throw (DPDT).

- C. Contact Rating: 10-Amps, 120-VAC/DC, minimum.
- D. Coil Voltage: 24-VDC or 120-VAC, as required.

## **2.18 INSULATED CONDUCTORS**

- A. Insulated conductors used to connect components external to enclosure are in accordance with Section 26 05 10 – Conductors and Cables.

## **2.19 SURGE SUPPRESSION**

- A. 4 to -20 mA Transient Protection Modules:
  - 1. Triple stage hybrid protection.
  - 2. Rated Voltage: 24-VDC
  - 3. Rated Current: 10-Amps
  - 4. Surge Current (8/20 microsecond wave form): 2.5kA, minimum.
  - 5. Clamping Voltage: 30-VDC, maximum.
  - 6. Response Time: Less than 5-nanoseconds.
  - 7. Throughput Resistance: 12-Ohms, maximum.
  - 8. Suppressor condition status indicator.
  - 9. Automatically resets after each transient.
- B. Line Voltage Surge Protection Device:
  - 1. Rated Voltage: 120-volt, 60-hertz.
  - 2. Rated Current: 15-Amps.
  - 3. Single-phase service.
  - 4. Surge Current (8/20 microsecond wave form): 7 kA, minimum.
  - 5. Clamping Voltage: 270-volts, maximum.
  - 6. Maximum Continuous Operating VAC (MCOV): 115 percent rated line voltage.
  - 7. Response Time: Less than 5-nanoseconds.
  - 8. Modes of Protection: L-N, L-G, N-G.
  - 9. Suppressor condition status indicator
  - 10. Automatically resets after each transient.
- C. For automation equipment in outdoor enclosures, surge suppression is required for all power supply inputs and wiring leaving enclosure, including digital I/O, analog I/O, and communication wiring.

## **2.20 COMPONENT LIFE CYCLE / SUPPORT**

- A. Components for SCADA System shall be chosen to maximize installation life-cycle and extend the time to replacement to the extent possible. Components shall be chosen with the following characteristics to help provide maximum life-cycle of the installation:
  - 1. Components from established product lines and manufacturers.
  - 2. Components from the most recent generation of equipment available from their manufacturer. Components where a later generation of equipment with a similar functionality is available shall not be acceptable except where specifically identified in this Section.
- B. Software packages used in the installation and for development of system graphics, control logic, etc. shall be up-to date and compatible with the most recent version of major operating systems, including Microsoft Windows.

## **2.21 SOURCE QUALITY CONTROL**

- A. Government reserves the right to inspect equipment at supplier's manufacturing plant prior to final testing.

## **PART 3 EXECUTION**

### **3.01 DESIGN COORDINATION MEETINGS**

- A. Conduct design coordination meetings and/or conference calls on a monthly basis per Section 1.08 – Design Coordination Meetings, beginning at contract award.
- B. Provide meeting records for each coordination meeting and conference call per RSN 25 00 01-2, Monthly Design Coordination Meeting and Conference Call Records.

### **3.02 INSTALLATION**

- A. In accordance with manufacturer's recommendations, with suitable and secure fasteners.
- B. Incorporate into the SCADA system, at a minimum, the instrumentation and control I/O points identified in Section 51 00 20 – I/O Points List and the Piping and Instrumentation Diagram (P&ID) shown in drawings Pumping Plant No. 4 1695-D-60507 through 1695-D-60515 and Pumping Plant No. 7 1695-D-60516 through 1695-D-60521.
- C. For connections to the programmable controllers which run outside the pumping plant building, surge suppression is required, including digital and analog I/O.
- D. Contractor is responsible for determining the final installed layout, wiring connections and schematic diagrams based on field installed equipment and design coordination meetings.

- E. Make wire between the SCADA equipment cabinet terminal blocks and the programmable controller's field wiring arms with NEC type SIS No. 18 AWG switchboard wire.
- F. All connections shall be made to place control and monitoring system into operation.
- G. Terminal Blocks:
  - 1. Arrange terminal blocks to segregate signal types and account for spare space.
  - 2. Arrange terminal blocks to allow external cabling to be supported.
  - 3. Mount terminal blocks at least 3-inches from panel edges and other devices. Mount adjacent rows of terminal blocks with 12-inches separation minimum. Access to front of terminal blocks shall be unobstructed.
  - 4. Machine lettered terminal numbers on terminal block marking strips. Do not use hand lettering.
  - 5. Identify vertical columns of terminal blocks with single letter such as "A", "B", or "C". Vertical columns may contain more than 12 termination points.
  - 6. Terminals:
    - a. Binding-head or washer-head screws with serrated or grooved contact surfaces.
    - b. Spring-clamp type terminal blocks are not acceptable.
  - 7. Voltage rating: 300-volts.
  - 8. Current rating: 20-amps.
  - 9. Analog Inputs shall be of disconnecting switch type terminal blocks.
- H. Cable and Wiring:
  - 1. Provide cable and wiring in accordance with Section 26 05 10 – Conductors and Cables and Section 26 05 02 – Basic Electrical Materials and Methods.
  - 2. Wire Connections:
    - a. Make connections at device terminals or terminal blocks. Maximum two wires per termination point.
    - b. Install incoming 120-volt branch circuits on adjacent terminal block terminals.
    - c. Install ring tongue connectors for terminations at terminal blocks and electrical devices. Use pin-type terminal connectors where use of ring tongues is not practical such as terminations at selector switches, pushbuttons, indicating lamps, and auxiliary relays.
    - d. Do not terminate wire without terminal connector.
    - e. Wire splices are not acceptable.

- I. Line power for all control and monitoring equipment shall be supplied from Contractor provided UPS system(s).
- J. All networking cabling shall provide a designated and easily identified to-and-from location marker at each end of cable.
- K. Make cable and conduit connections. Use watertight conduit hubs for conduit connections.
- L. Make grounding and bonding connections in accordance with Section 26 05 20 – Grounding and Bonding, NFPA 70, and IEEE 1100.
- M. Control Cable and Wire Identification: In accordance with Section 26 05 10 – Conductors and Cables.
- N. Provide all software and associated programming/configuration required to meet performance requirements of Contract Documents:
  - 1. At substantial completion of Project:
    - a. Turn current licenses for all software over to Government in Bureau of Reclamation's name and install latest version, upgrade or service pack for all software.
  - 2. Provide respective software supplier's Comprehensive Support Contract for all software and network components covering full one-year warranty period following substantial completion which shall provide no cost software upgrades, service packs and tech support from software or network component supplier.
- O. Nameplates:
  - 1. Provide nameplates for Contractor supplied equipment in accordance with Section 26 05 02 – Basic Electrical Materials and Methods.
- P. Installation shall look complete and professionally done, all damage to enclosures or installation area shall be repaired and left in a finished condition.

### **3.03 FIELD ADJUSTMENTS**

- A. Provide in accordance with Section 01 80 15 – Commissioning.

### **3.04 CONTRACTOR FIELD QUALITY TESTING**

- A. Perform field wiring checkout and test in accordance with Section 26 05 90 – Wiring Checkout and Tests.
- B. Perform system testing in accordance with Section 01 80 15 – Commissioning.

**END OF SECTION**

**SECTION 26 05 02**  
**BASIC ELECTRICAL MATERIALS AND METHODS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include cost in applicable prices offered in the Price Schedules, for items requiring electrical equipment and materials.
2. Payment under various items includes cost of:
  - a. Performing required design.
  - b. Furnishing recently certified calibrated testing equipment.
  - c. Performing testing.
  - d. Transporting and storing equipment and materials.
  - e. Modifying and relocating equipment.
  - f. Placing, leveling, and grouting channel bases.
  - g. Assembling, adjusting, and installing equipment.
  - h. Painting equipment and materials.
  - i. Brackets, fasteners, bolts, nuts, lock washers, and other accessories required for mounting or installing electrical equipment and materials.
  - j. Drilling holes in steel structures (other than tubular structures) as required for mounting or installing electrical equipment and materials.
  - k. Furnishing, handling, and storing spare parts for electrical equipment.
  - l. Furnishing special tools and appliances for maintenance and adjustment of equipment.
  - m. Making electrical connections; furnishing all miscellaneous materials, which are required for making the connections to electrical equipment. Contractor estimates the number of connections to be made to the equipment based on prior knowledge or experience with similar equipment. No additional compensation will be allowed Contractor in the event that actual connections exceed number estimated by Contractor at time of bidding.
  - n. Performing wiring checkout and tests.

## 1.02 REFERENCE STANDARDS

- A. ASTM International (ASTM)
  - 1. ASTM A123/A123M-15 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - 2. ASTM A153/A153M-16a Zinc Coatings (Hot-Dip) on Iron and Steel Hardware
- B. Institute of Electrical and Electronics Engineers (IEEE)
  - 1. IEEE C2-2012 National Electric Safety Code (NEC)
- C. National Electrical Installation Standards (NEIS)
  - 1. NECA 1- 2010 Good Workmanship in Electrical Contracting
- D. National Fire Protection Association (NFPA)
  - 1. NFPA 70-2014 National Electrical Code (NEC)

## 1.03 EXTRA MATERIALS

- A. Provide to Government special tools and equipment necessary to properly install, adjust, test, and check operation of electrical equipment. Furnish all additional tools and equipment as necessary to properly install, adjust, and check the operation of electrical equipment.

## PART 2 PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT

- A. Conform to NFPA 70 and IEEE C2.
- B. Furnish all electrical materials and equipment.
- C. Galvanize mounting brackets, bolts, nuts, and washers for major items of electrical equipment such as the outdoor unit substations and the motor control centers in accordance with ASTM A123 and ASTM A153.
- D. Provide galvanized steel or non-corrosive metal for mounting bolts, nuts, and washers for minor items of electrical equipment and lighter weight items. Do not use cadmium-plated mounting hardware.
- E. Change designs as required where Contractor-furnished electrical equipment and materials differ in size, type, ratings, or other physical properties from designs in these specifications. CO will approve changes at Contractor's expense, unless Contractor can demonstrate that changes are necessary regardless of manufacturer.

- F. Provide special tools and appliances furnished by manufacturer for maintenance and adjustment of manufacturer's electrical equipment.
- G. Use test equipment that has been calibrated within 365-days of its use with calibration sticker clearly visible.
- H. Deliver all spare parts required by these specifications to Bureau of Reclamation only after completion of contract.

## **2.02 SOURCE QUALITY ASSURANCE**

- A. Government will inspect the outdoor switchgear and motor control equipment at supplier's manufacturing plant during fabrication and testing. However, final acceptance will not be made until equipment has been installed and is operational.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install, assemble, and adjust equipment in accordance with this subparagraph. These specifications requirements are based on the premise that no conflict exists between specified design, standards, and codes. However, in the event a conflict is discovered by Contractor, it will be Contractor's responsibility to inform CO of the conflict:
  - 1. In the event of conflicting requirements, establish precedence by the following order:
    - a. These specifications or as directed by CO.
    - b. Drawings included in these specifications.
    - c. Latest edition of "National Electric Code" of the National Fire Protection Association for electrical wiring apparatus and the adopted electrical code of the State in which construction is located. Cooperate with any agency designated by that State to inspect electrical installation for conformance with applicable State code.
- B. Do not install electrical equipment until approval drawings and data for associated equipment have been approved by Government.
- C. Electrical Installations, Assembly Operations, and Adjustments: Comply with NFPA 70, IEEE C2, and NECA 1.
- D. Make electrical installations complete and ready for service.
- E. Install electrical equipment in accordance with directions furnished by manufacturer's instruction books.
- F. Make all electrical wire, cable, conduit, and grounding connections and furnish all miscellaneous materials which are required for making these connections to equipment.

- G. Install items of electrical equipment that are required to be in a lineup so appearance is uniform, including height, depth, color, and general construction.
- H. Tighten nuts used in electrical equipment assembly with torque wrenches to torque values recommended by equipment manufacturers.
- I. Drill holes in bolted steel structures and provide fastenings required for mounting or installing electrical equipment and materials.
- J. Do not drill holes in tubular steel structures. Fasten to tubular steel structures by means of properly drilled and tapped pads or brackets welded to tubular members.
- K. Installation of Electrical Equipment Includes:
  - 1. Leveling and grouting channel bases.
  - 2. Drilling holes, furnishing hardware, and assembling components to each other.
  - 3. Furnishing materials for and making all connections correctly in accordance with final wiring diagrams.
  - 4. Tagging wires and cables at each end.
  - 5. Correcting any errors made by Contractor in installation at no expense to Government.
  - 6. Wiring and checkout of all equipment in accordance with Section 26 05 90 – Wiring Checkout and Tests.
- L. Set electrical equipment installed on concrete foundations on channel bases and grout in place to provide full and even bearing.

### **3.02 REPAIR**

- A. Repair or replace damaged devices and repair damaged painted surfaces of equipment to match original finish.
- B. Correct by repair or replacement, at the Contractor's expense, all damage to or failure of any part of the items of material and equipment which in the opinion of COR was caused by faulty installation, faulty mechanical assembly, or mishandling.

### **3.03 FIELD QUALITY ASSURANCE**

- A. Government will inspect outdoor switchgear and motor control equipment during construction. Acceptance of equipment will be made after equipment is operational.

**END OF SECTION**

**SECTION 26 05 10**  
**CONDUCTORS AND CABLES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Conductors and Cables:
1. Measurement: Length of installed conductor or cable.
  2. Payment: Linear foot prices offered in the Price Schedules for applicable conductor or cable size.
- B. Cost: Include cost of making electrical connections to equipment and devices in prices offered in the Price Schedules for equipment and devices that require connections.

**1.02 REFERENCE STANDARDS**

- A. ASTM International (ASTM)
1. ASTM B8-11(2017) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Building Industry Consulting Service International (BICSI)
1. BICSI-TDMM-13<sup>th</sup> Edition Telecommunications Distribution Methods Manual (TDMM)
- C. Insulated Cable Engineer Association (ICEA)
1. ICEA S-87-640-2016 Optical Fiber Outside Plant Communications Cable
  2. ICEA S-90-661-2012 Category 3, 5, and 5e Individually Unshielded Twisted Pair Indoor Cables for Use in General Purpose and LAN Communications Wiring Systems
  3. ICEA S-116-732-2013 Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With or Without An Overall Shield) for Use In LAN Communication Wiring Systems
- D. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE C2-2012 National Electrical Safety Code (NESC)

- E. National Electrical Contractors Association (NECA)
1. NECA/BICSI 568-2006 Installing Building Telecommunications Cabling
- F. National Electrical Manufacturers Association (NEMA)
1. NEMA WC 57-2014 Control, Thermocouple Extension, and Instrumentation Cables
  2. NEMA WC 70-2009 Nonshielded Power Cables Rated 2000V or Less for the Distribution of Electrical Energy
- G. National Fire Protection Association (NFPA)
1. NFPA 70-2014 National Electrical Code (NEC)
- H. Telecommunications Industry Association (TIA)
1. TIA J-STD-607-2012 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  2. TIA 568.0-D-2015 Generic Telecommunications Cabling for Customer Premises.
  3. TIA 568.1-D-2015 Commercial Building Telecommunications Infrastructure Standard
  4. TIA-568-C.1-2009 Commercial Building Telecommunications Cabling Standard
  5. TIA 568-C.2-2011 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
  6. TIA 568-C.3-2008 Optical Fiber Cabling Components Standard
  7. TIA 568-C.4-2011 Broadband Coaxial Cabling and Components Standard
  8. TIA -598-2014 Optical Fiber Cable Color Coding
  9. TIA-1152-2009 Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- I. Underwriters Laboratories, Inc. (UL)
1. UL 444-2013 Communications Cables
  2. UL 1581-2001 Standard for Electrical Wires, Cables, and Flexible Cords

- |    |              |  |
|----|--------------|--|
| 3. | UL 1666-2007 | Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts |
| 4. | UL 2024-2014 | Standard for Cable Routing Assemblies and Communications Raceways  |

### **1.03 DESIGN REQUIREMENTS**

- A. Determine conductor sizes, except where shown or specified, in accordance with NFPA 70. In the event of conflict between design requirements and NFPA 70, more stringent requirement applies.
- B. Verify conductor sizes where shown are provided appropriate for equipment under this contract. Provide conductor sizes and types appropriate for electrical load and installation conditions where used.
- C. Cable shall be rated appropriately for installation, and installation conditions where it is installed. At a minimum cable shall be rated for wet or dry applications, and for installation in cable trays.

### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 05 10-1, Approval Data:
  - 1. Manufacturer’s catalog data.
- C. RSN 26 05 10-2, Construction Documentation:
  - 1. Test Reports and Wire Termination Sheets:
    - a. Provide test reports for each cable provided by the Contractor.
    - b. Include electronic PDF and paper copy of each trace made during testing.

### **1.05 DEFINITIONS**

- A. Cable: Cable, cables, wire, or wires of one or more insulated conductors.
- B. Power Cable: For power loads including motors; alternating-current distribution circuits; heating, ventilating, and air-conditioning and lighting circuits; and cable that is used for controlling heating, ventilating, air-conditioning, and lighting equipment.
- C. Building Premises Wire: For connection of separately-housed components such as wiring devices and luminaire circuits to branch circuit breakers and to one another.
- D. Control Cable: For control, metering, indication, annunciation, and relaying circuits; and circuits not identified as power circuits.

- E. Instrumentation Cable: Power limited cable for RTD, transducer output circuits, and can be used for serial communication (RS-232 & RS-485).
- F. Telecommunications Cable: For supervisory computer control, data, voice communication, and logic level signals.
- G. Enclosure Wiring: For wiring inside of enclosures or control boards.
- H. Life Safety Cable: For fire protection system devices providing detection, notification, and suppression.

## **PART 2 PRODUCTS**

### **2.01 CABLE, GENERAL**

- A. Manufactured no more than 24-months prior to Notice to Proceed.
- B. Conductors:
  - 1. Copper in accordance with ASTM B8, class B or C.
  - 2. Stranded conductors, except for solid conductor building premises wire.
- C. AWG or kcmil designation.
- D. Coverings or insulation: Suitable for installation in vertical position without injury to covering or deformation of insulation when supported in accordance with NFPA 70.

### **2.02 PHASE IDENTIFICATION**

- A. Power Cable Phase Conductors and Building Premises Wire:
  - 1. 120/240, single-phase: Black.
  - 2. 120/208 or 240 volt. 3-phase: Black, red, blue. Colored phase tape may be used in lieu of colored insulation.
  - 3. 277/480 volt, 3 phase: Black with brown, orange, yellow phase tape.
  - 4. Direct Current (Ungrounded) Conductors:
    - a. 125-volt DC positive bus: Red.
    - b. 125-volt DC negative bus: Black.
- B. Neutral (Grounded) Conductors: In accordance with NFPA 70.
- C. Equipment Grounding Conductors:
  - 1. 6 AWG and smaller: Green insulation.
  - 2. Larger than 6 AWG: Green tape at both ends and visible points including junction boxes.

## **2.03 COLOR CODING**

- A. Colored insulation or jacket compound. Do not apply color coatings to insulation or jacket surface.
- B. Control Cable:
  - 1. In accordance with NEMA WC 57, Table E-2.
- C. Instrumentation Cable
  - 1. Sequentially number each pair/triad for identification.

## **2.04 SERVICE LIFE**

- A. Designed and manufactured for a service life of at least 40-years.

## **2.05 POWER CABLE**

- A. Type:
  - 1. Single-conductor or multi-conductor, non-shielded type.
  - 2. Labeled type TC when installed in cable tray.
- B. Size: 12 AWG, minimum.
- C. 600-volt rated insulation unless specified otherwise.
- D. Color Coding:
  - 1. Power Cable Phase Conductors and Building Premises Wire:
    - a. 120/240, single-phase: Black, Red.
    - b. 120/208- or 240-volt 3-phase: Black, Red, Blue. Colored phase tape may be used in lieu of colored insulation.
    - c. 277/480-volt, 3-phase: Black with Brown, Orange, Yellow phase tape.
  - 2. Neutral (Grounded) Conductors:
    - a. 6 AWG and smaller: White insulation.
    - b. Larger than 6 AWG: White insulation or White tape at both ends and visible points including junction boxes.
  - 3. Equipment Grounding Conductors:
    - a. 6 AWG and smaller: Green insulation or Green with one or more Yellow stripes.
    - b. Larger than 6 AWG: Green tape at both ends and visible points including junction boxes.

- E. Suitable For:
  - 1. Installation in raceways.
  - 2. Installation in cable trays when required by specifications.
- F. Insulation Type:
  - 1. Single- or multi-conductor cable: THHN/THWN or XHHW.
- G. Multi-conductor Overall Jacket:
  - 1. Type: PVC (Polyvinyl chloride) or better, flame-retardant.
- H. In accordance with NEMA WC 70. Cable UL listed and labeled.
- I. Provide multi-conductor power cable with integral ground conductor. Size ground conductor in accordance with NFPA 70.

## **2.06 MULTICONDUCTOR CONTROL CABLE**

- A. Type:
  - 1. Non-shielded type.
  - 2. Labeled type TC when installed in cable tray.
- B. Size: 16 AWG, minimum.
- C. 600-volt rated insulation unless specified otherwise.
- D. Color Coding:
  - 1. Colored insulation or jacket compound. Do not apply color coatings to insulation or jacket surface.
  - 2. In accordance with NEMA WC 57, Table E-2.
- E. Suitable For:
  - 1. Installation in raceways.
  - 2. Installation in cable trays when required by specifications.
- F. Insulation Type:
  - 1. XHHW.
- G. Multi-conductor Overall Jacket:
  - 1. Type: PVC (Polyvinyl chloride) or better, flame-retardant.
  - 2. Jacket thickness:
    - a. 16 AWG conductors: 45 mils for 12 conductor or less. 60 mils for greater than 12 conductor.

- b. 14 AWG conductors: 45 mils for 9 conductor or less. 60 mils for greater than 9 conductor.

H. In accordance with NEMA WC 57. Cable UL listed and labeled.

## **2.07 BUILDING PREMISES WIRE**

A. Type: Single, solid conductor.

B. Size: 12 AWG or as shown.

C. 600-volt rated insulation unless specified otherwise.

D. Color Coding:

1. Phase Conductors:

- a. 120/240, single-phase: Black, Red.
- b. 120/208- or 240-volt 3-phase: Black, Red, Blue.
- c. 277/480-volt, 3-phase: Brown, Orange, Yellow.

2. Neutral (Grounded) Conductors:

- a. White insulation.
- b. Larger than 6 AWG: White insulation, or White tape at both ends and visible points including junction boxes.

E. Suitable For: Installation in raceways.

F. Insulation Type:

1. 600-volt. THHN/THWN.

G. Conform to NEMA WC 70. UL listed and labeled.

## **2.08 INSTRUMENTATION CABLE**

A. Type: Twisted, single-pair or twisted triad shielded or multiple individual twisted shielded pairs or twisted triads with overall shield.

B. Suitable for installation in raceways and cable tray.

C. Size: 16 AWG or as shown.

D. Insulation: 300-volt, 105 degrees C, minimum.

E. Single-Pair or Triad Shield: Aluminum-Mylar tape providing 100 percent coverage with a tinned, stranded copper drain wire.

- F. Multiple Pair or Triad Shield:
1. Pair or triad shield: Aluminum-Mylar tape providing 100 percent coverage with a tinned, stranded copper drain wire.
  2. Cable shield: Aluminum-Mylar tape providing 100 percent coverage with a tinned, stranded copper drain wire.
  3. Each pair or triad sequentially numbered for identification.
- G. Jacket: Black PVC with rip-cord.

## **2.09 TELECOMMUNICATIONS CABLE**

- A. Optical Fiber Cable:
1. Provide cable in accordance with ICEA S-87-640, as appropriate.
  2. Cable performance shall not be impacted by immersion in water.
  3. UL listed, where available.
  4. Color Coding: Per TIA-598.
  5. Single Mode Optical Fiber Cable:
    - a. Major cable components;
      - 1) Protect each fiber in a buffer tube of gel free, standard loose-tube type construction.
      - 2) 2.5 mm buffer tubes, color coded.
      - 3) Central dielectric strength member: glass reinforced plastic (GRP) rod filler.
      - 4) Cable core: Symmetrically stranded buffer tubes around dielectric central member.
      - 5) Water swellable yarn or water blocking protection.
    - b. Optical fibers:
      - 1) 100 percent synthetic silica.
      - 2) Cladding diameter: 125-microns.
      - 3) Core/clad concentricity error: < 0.5 microns, < 0.2 microns typical.
      - 4) Cladding non-circularity: < 1.0.
      - 5) Primary buffer coating: 250 microns.
      - 6) Attenuation of 1310/1383/1550 nanometer wavelength light: Less than 0.5/0.5/0.4 dB per kilometer.
      - 7) Attenuation: Directly proportional to cable length for an arbitrary cable length section after steady-state conditions are reached.

- 8) Bend Insensitive Single-mode Fiber.
  - 9) Color coded.
  - 10) Quantity of fibers as shown on supplied drawings and as required to complete installation.
- c. Cable Jacket:
- 1) Type: PVC (Polyvinyl chloride) or CPE (Chlorinated Polyethylene) or better, UV resistant, flame-retardant.
  - 2) Ripcord under sheath.
- d. Strength members: With expansion and contraction characteristics similar to glass fibers.
- e. Cable Bend Radius:
- 1) Loaded: 7.7-inch.
  - 2) Unloaded: 5.1-inch.
- f. Cable tensile strength:
- 1) Long term (installed): 135 pounds per foot.
  - 2) Short term (during installation): 600 pounds per foot.
- g. Operating temperature range: -40 to 150 degrees F.
- h. Suitable for installation in innerduct.
- B. Optical Fiber Patch Cable:
1. Type fiber: Single-mode.
  2. Length: As required.
  3. Connectors: As required to connect to fiber optic equipment.
  4. Loss per connector: Less than 0.5 decibels.
- C. CAT 3 Cable:
1. Provided per ICEA S-90-661, UL 444, and TIA-568-C.2.
  2. Cable UL listed and labeled.
  3. Conductors:
    - a. AWG designation.
    - b. Minimum Conductor Size:
      - 1) Minimum size 22 AWG.

4. Type:
    - a. UL listed CMR cable, unless otherwise required for installation conditions.
    - b. Single twisted pair, or multiple individual twisted pairs. Quantity of pairs as required for application.
    - c. Suitable for installation in above grade or underground raceways.
  5. Rated for a minimum of 60 degrees C continuous operating temperature, Wet or Dry.
  6. Insulation:
    - a. PVC or equal.
  7. Jacket:
    - a. PVC (Polyvinyl chloride) or equal with rip-cord.
    - b. Moisture resistant.
  8. Flame Test Rating:
    - a. UL 1666 Riser.
  9. Provide communications rated cabling for installation purpose it is installed (plenum, riser, etc.) in accordance with NFPA 70.
- D. CAT 6 Cable:
1. Provided per ICEA S-116-732, UL 444, and TIA-568-C.2.
  2. Four twisted pair, minimum size 24 AWG conductors.
  3. Provide communications rated cabling for installation purpose it is installed (plenum, riser, general purpose, etc.) in accordance with NFPA 70.
  4. UL listed and labeled for wet locations.
  5. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating and length marking at regular intervals.
- E. Special Purpose Cable:
1. With approval of COR.

## **2.10 ENCLOSURE WIRING**

- A. Wiring inside switchboards, switchgear, control panels, etc., not intended for use extending outside of enclosure. Enclosure wiring for instrumentation or telecommunications shall maintain characteristics of those cable types.
- B. Minimum 600-volt rated insulation.

- C. Type:
  - 1. NEC type SIS.
  - 2. VW-1 Rated.
  - 3. UL Listed.
- D. Minimum Conductor Size:
  - 1. 14 AWG.
  - 2. Conductor sized according to application requirements, and in accordance with requirements and recommendation in NEC.
- E. Insulation Type:
  - 1. XLPE, or equal.
- F. Insulation Color:
  - 1. White or Grey, unless special purpose application.
- G. Flame Test Rating:
  - 1. UL 1581 VW-1.

## **2.11 COAXIAL CABLE**

- A. Provided per TIA-568-C.4.
- B. Type: Radio Communication.
- C. RG Type: 58/U.
- D. Impedance: 50 Ohms.
- E. All copper center conductor.
- F. All-copper braided shield with 95 percent braid coverage.
- G. Jacket: Low Smoke Polyvinyl Chloride (PVC).
- H. For use in radio circuits.

## **2.12 LIFE SAFETY CABLE**

- A. Shielded, solid copper, polyvinylchloride (PVC) insulation and an overall flame retardant PVC jacket.
- B. UL listed as Fire Power Limited Plenum (FPLP).
- C. Shielded: 0.007-inch thick insulation and 0.015-inch jacket thickness minimal.

## 2.13 ACCESSORIES

### A. Single Conductor Markers:

1. Type: Heat-shrink, machine printable sleeve.
2. Color: White with Black text.
3. Text size: As large as practical but at least 7 point (0.06-inch).
4. Be 1-inch in length, minimum, and have diameter suitable for installation on intended conductor.

### B. Multi-conductor Cable Tags:

1. Type: Cross-laminated polyethylene film or Nomex®. Be resistant to water, oil, solvent, abrasion, and tearing.
2. Rectangular shape and have minimum dimensions of 2- by 0.5-inches.
3. Color: White with Black text.
4. Text size: As large as practical but at least 16 point (0.16-inch).
5. Attach to cable with standard nylon self-locking tie wraps or cable ties.

### C. Polyethylene warning tape.

1. Width: 6-inches.
2. Suitable for direct burial.
3. Power Circuit:
  - a. Color: Red.
  - b. Continuously imprinted with "CAUTION BURIED ELECTRIC LINE BELOW".
4. Communications Circuit:
  - a. Color: Yellow
  - b. Continuously imprinted with "CAUTION BURIED CABLE BELOW".

### D. Terminal Connectors for Control and Instrumentation Cable:

1. Heavy-duty, insulated, pressure-crimp-type with ring tongues. 600-volt, pressure-crimp pin type may be used where use of ring tongue connectors is not practical.
2. Tin-plated copper.
3. Serrated inner barrel.
4. UL listed.
5. Compatible with conductor size and type of cable for which it is used.

- E. Telecommunications Cable Faceplates and Connectors:
1. Connectorize fiber cables and connect to patch panels using ST type connectors. Make connections to components as required by component terminal.
  2. Provide patch cords to connect dielectric fiber cable to fiber optic equipment.
  3. Terminate unshielded twisted pair (UTP) cables in accordance with TIA-568-C.1 and TIA-568-C.2 with T-568A color configuration.
  4. Use registered jack (RJ) 45 modular connector.
  5. Provide each location with 2 port RJ-45 faceplates unless otherwise noted on drawings.
  6. Faceplate color shall be White.
- F. Fiber Optic Cable Patch Panels:
1. Type: Rack mount or wall mount.
  2. Metal housing with splice tray holder, splice tray, adaptor plates, and radius limiters.
  3. Splice Trays:
    - a. Same manufacturer as housing.
    - b. Fusion splice organizer to retain each splice and its shrink tubing.
    - c. Manufactured for loose tube type fiber optic cable.
  4. Adaptor Plates:
    - a. Same manufacturer as enclosure.
    - b. Mount at minimum 6 fibers.
    - c. Use ST Connectors.
- G. Innerduct Duct Liners:
1. Conform to UL 2024 and applicable ASTM standards.
  2. UL Riser-Rated.
  3. Size: 1-inch.
  4. Flexible.
  5. Non-metallic.
  6. Corrugated:
    - a. Sequential marked footage.
- H. Optical Fiber Splice Closure:
1. Re-enterable splice enclosure:
    - a. Factory installed sealing materials.

- b. Re-enterable and reusable.
  - c. Telcordia GR-771 compliant.
  - d. Flame retardant UV stabilized material.
  - e. International Electrotechnical Commission (IEC) Ingress Protection Rating (IP), IP-68 Rating compliant.
2. 12 fiber splice, minimum.
  3. Grommet sealing system to support flat or round cable profiles.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with NFPA 70, IEEE C2, BICSI-TDMM, NECA/BICSI 568, TIA 568-C.2, UL, and manufacturer's requirements and recommendations.
- B. Maintain manufacturer recommended minimum bending radius for cables.
- C. Install all telecommunications cables in raceway, cable tray or similar protected installation.
- D. Provide circuit raceway and cable tray in accordance with Sections 26 05 33 – Raceway and Boxes and 26 05 36 – Cable Trays.
- E. Do not damage or chafe outer jacket material.
- F. When using cable ties, do not over tighten, to ensure tie does not cut conductor insulation or cable outer jacket. Do not use cable ties to support cables.
- G. Seal cable penetrations into equipment or passing through blockouts, with silicone-foam, fire-retardant type material in accordance with NFPA 70.
- H. Install cable in a neat and workmanlike manner in accordance with industry standards and manufacturer requirements.
- I. Use building premises wire for lighting circuits and 120V receptacles unless shown otherwise.
- J. Cable Separation:
  1. Install cables to provide separation of voltage levels, defined below, except with approval of COR.
  2. Voltage Levels:
    - a. 64V operating voltage and above.
    - b. Below 64V operating voltage.

3. Do not mix voltages within a cable.
4. Do not install cables of different voltage levels in same raceway.
5. Do not install cables of different voltage levels in same cable tray unless separated by barrier in cable tray.

K. Cable Splicing:

1. Fiber Optic Cable:
  - a. Do not splice fiber optic cables outside of patch panels.
  - b. Fiber optic splicing:
    - 1) Method: Arc-fusion.
    - 2) Splices per set of fusion tips: 50.
      - a) Splice loss: 0.1 decibels, average bi-directional.
2. All other cable types: Do not splice cables.

L. Cable Installed in Conduit:

1. Do not pull cable into conduit until they have been cleaned and are free from obstructions and sharp corners.
2. Draw clean, dry, tight-fitting rag through conduit immediately before installing cable.
3. Install cable using gradual and uniform pulling stresses. Do not exceed allowable pulling tensions and sidewall pressures as recommended by cable manufacturer.
4. Install cable to prevent cuts or abrasions in insulation or protective covering and kinks in cable.
5. When lubricant is needed as an aid to pulling, use only soapstone or other suitable lubricant that is not injurious to cable insulation.
6. When mechanical cable pulling equipment is used, use tension meter release mechanism to ensure pulling tension remains below tensile strength of cable.
7. Remove and replace with new cable that is damaged during installation.
8. Do not install wiring for fire alarm system in conduits, junction boxes, or outlet boxes with conductors of other systems. Conduit shall be dedicated to fire protection system.

M. Cable Installed in Vertical or Inclined Plane:

1. Install in locations shown. If not shown, install in accordance with NFPA 70.
2. Support with cable grips leaving slack spans between supports.
3. Clamp cable entering enclosures, junction boxes, or equipment with commercial cable clamps.

4. Cables shall not be installed in an open air drop of greater than 4-feet without explicit approval of COR.
- N. Cable in Boxes and Enclosures:
1. Provide slack in cable in all boxes, and enclosures. Cable should not be pulled tight against any edge or component in enclosures and boxes.
  2. If cable is terminated in box or enclosure include enough spare length in terminated conductor to reach any other terminal in enclosure. In multi-panel control cabinets conductor should be able to reach any other terminal within that panel of enclosure.
- O. Fiber optic cables:
1. Innerduct Duct Liners:
    - a. Where fiber optic cable is installed in conduits or ducts install cable in 1-inch innerduct. Fiber optic cable shall be compatible with innerduct and lubricants provided.
    - b. Provide minimum of three empty innerduct duct liners for future use in each conduit or duct with fiber optic cable.
    - c. Provide pulling tape in each innerduct duct liner.
  2. Termination:
    - a. Terminate fiber optic cable installed between enclosures or building at patch panels.
    - b. Coil 10-feet of fiber cable inside each patch panel.
    - c. Leave spare fibers in each patch panel.
    - d. Retain fibers at each cable end equal in length to longest single fiber.
  3. Provide fiber optic coils inside pull boxes, junction boxes, and other electrical and control enclosures, and where recommended by manufacturer.
  4. Clamp cable entry with fiber type cable clamp.
- P. CAT 3 and 6 cables:
1. Install in accordance with BICSI-TDMM, TIA-568-C.2, NFPA 70, and UL standards as applicable.
  2. Install per manufacturer's instructions and do not exceed manufacturers' cable pull tensions for copper cables.
  3. Install back boxes for RJ-45 connectors.
  4. Do not install power and communication cable in same conduit.
  5. No cable shall contain unterminated elements.
  6. Do not untwist Category 6 cables more than 1/2-inch from point of termination to maintain cable geometry.

7. Terminate networking cables in T568A configuration per TIA-568-C.2.
- Q. Direct buried cables:
1. Install in accordance with standard drawing 40-D-5370.
  2. Only cable utilized for building premise applications can be direct buried.
- R. Grounding:
1. Provide one non-active conductor, grounded at both ends, in each multi-conductor control cable.
  2. Ground shielding of each shielded control cable on both ends directly to equipment ground bus.
  3. Ground shielding of instrumentation and telecommunications cable only to source equipment ground bus.
  4. Ground spare conductors by wire jumpers from equipment terminal block points to equipment ground bus.
  5. Provide grounding and bonding in accordance with TIA J-STD-607.
- S. Wiring Methods:
1. Terminate control and instrumentation cable with terminal connectors.
  2. At termination point of multi-conductor cables, form conductors into neat packs and tie with self-locking cable ties.
  3. Do not combine current and potential transformer circuits in same multi-conductor cable with control circuits.
  4. Clamp cable entering equipment with commercial type cable clamps.
  5. Leave sufficient length cable ends to make connections conveniently to equipment, fixtures, and devices.
  6. Provide 5-conductor cable for each three-phase current and each potential transformer circuit. Use No. 10 AWG conductors for current transformer circuits.
  7. Retain sufficient length of conductors in a current transformer cable length to reach farthest terminal used to select current transformer ratios.
  8. Retain spare single conductors at each end of multi-conductor cable in length equal to longest single conductor of multi-conductor cable.
  9. Terminate spare conductors of multi-conductor cable at terminal blocks. Ground spare conductors by using wire jumpers between terminations and equipment ground bus.
  10. Run both positive and negative leads of direct-current circuit in same cable.

### 3.02 CABLE AND CONDUCTOR IDENTIFICATION

#### A. Power Cable:

1. Identify power conductors that are service conductors, panelboard and switchboard feeders, motor control center feeders, and motor power conductors with colored insulation or colored phase tape in accordance with this section. An additional conductor marker is not required.
2. Provide single-line marker on load end of feeder and branch-circuit conductors that originate at panelboards, switchboards, and motor control centers. Marker to include designation of source equipment and circuit number.

#### B. Conductor Markers:

1. Text to be machine or computer generated. Hand written text is not acceptable.
2. Provide individual conductors of multi-conductor control cable and instrumentation cable, with conductor marker. Print conductor designation, as shown on approved schematic diagram, on first line. Print conductor destination and device terminal number on second line.
3. Single line conductor marker will be acceptable provided conductor designation is enclosed in parenthesis followed by conductor destination.
4. Do not heat shrink marker onto conductor. Allow marker to rotate about conductor.
5. Mark both end of conductors with port number and room location of connected switch/punch down block.
6. Provide markers for spare conductors of multi-conductor cables. Marker to include cable designation and the word "SPARE". Numerically sequence spare conductor markers e.g. (1CSA-CSB-SPARE1, 2CSA-CSB-SPARE2, etc.).

#### C. Multi-Conductor Cable Tags:

1. Tag multi-conductor cables at each end.
2. Text to be machine or computer generated. Hand written text is not acceptable.
3. Mark tags with cable designations as shown on approved wiring and interconnection diagrams. Cable designation to be single-line of text that includes cable number, originating equipment designation, and destination equipment designation. Develop cable designations when not shown. Examples of cable designations are:
  - a. 1MCA-DV1 – First cable from motor control center MCA to discharge valve No. 1).
  - b. 3MCB-ACP – Third cable from motor control center MCB to auxiliary control panel ACP.
4. Attach tags to cable with self-locking tie wraps or cable ties.

### 3.03 CONTRACTOR FIELD QUALITY CONTROL

- A. Notify COR, in writing, of date, time, and cables to be tested at least 5 working days before testing. Testing dates to be mutually agreeable between Contractor and COR.
- B. Perform testing after installation, but before connection to equipment.
- C. Test cables in large groups to minimize number of testing sessions.
- D. Perform following tests:
  - 1. Continuity test: Test continuity of each conductor prior to performing insulation resistance test.
  - 2. Insulation resistance tests:
    - a. Measure insulation resistance between each conductor and station ground with all other conductors in same cable or conduit grounded.
    - b. Test voltage: 1,000 volts direct-current, minimum.
    - c. Minimum acceptable insulation resistance:  $R$  in  $M\Omega = (\text{rated voltage in kV} + 1) \times 1,000/\text{length in feet}$ .
  - 3. Record following test data on test report for each conductor tested:
    - a. Date of test.
    - b. Name or names of Contractor's personnel who performed test.
    - c. Name of Government inspector who witnessed test.
    - d. Conductor identification.
    - e. Continuity.
    - f. Megohms between conductor and ground.
    - g. Total length of conductor.
- E. Perform the following tests - Fiber Optic cable:
  - 1. Test each fiber using an Optical Time Domain Reflectometer (OTDR):
    - a. Purpose and intent of testing:
      - 1) Determine if installed cable is free from defects.
      - 2) Compare measured attenuation with cable manufacturer's specified attenuation of 0.4 decibels per kilometer for 1,300 nanometer light.
      - 3) Compare measured bi-directional splice loss with specified splice loss of 0.1 decibels per splice.
      - 4) Compare measured connector loss with specified connector loss of 0.5 decibels.
      - 5) Verify cable length.

- b. OTDR requirements:
  - 1) Fiber type: Single-Mode.
  - 2) Dynamic Range: 25 decibels, minimum.
  - 3) Resolution: Selectable 0.1- to 10-meters.
  - 4) Pulse width: Selectable. 1 for all tests.
  - 5) Reflectance accuracy: Plus or minus 2 decibels.
  - 6) Loss accuracy (Linearity): 0.02 decibel per decibel.
- c. Obtain an OTDR waveform for each fiber to:
  - 1) Determine actual cable length.
  - 2) Determine attenuation and splice loss.
  - 3) Identify and locate splices and step discontinuities/possible fiber breaks.
- d. Prepare test reports:
  - 1) Generate a PDF copy and paper copy of each trace made during testing for inclusion in the report:
  - 2) OTDR waveform for each fiber showing “A” and “B” range marks:
    - a) Do not move or change location of either mark.
  - 3) Include an Analysis Summary Results Table for each fiber:
    - a) Indicate numerical values associated with each event.
    - b) Do not use question marks, dashes, or blanks.
  - 4) Include following information for each trace:
    - a) Trace name.
    - b) Operator’s name.
    - c) Date and time.
    - d) Fiber type being tested.
    - e) Bundle color.
    - f) Fiber color.
    - g) Fiber number.
    - h) Launch reel length.
    - i) OTDR resolution.
    - j) Pulse width.
    - k) Wavelength.

- l) Index of refraction.
  - m) Averaging number.
  - n) Receiver bandwidth.
  - o) Sampling point count.
  - p) End to end loss, decibels.
  - q) Reflectance, decibels.
  - r) Fiber Break, decibels.
  - s) Backscatter.
- 5) Traces to be viewable and reproducible on a PC using Windows 7 or later.
- F. Perform the following tests - CAT 6 cable:
- 1. Test equipment shall conform to TIA-1152.
  - 2. Inspect network cabling terminations for T568A color configuration.
  - 3. Perform testing for each outlet.
  - 4. Performance test:
    - a. Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA-568-C.2.
    - b. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
- G. Inspect coaxial connector integrity.
- H. If any cable or conductor fails testing, remove and replace cable.

**END OF SECTION**

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**SECTION 26 05 13**  
**MEDIUM-VOLTAGE POWER CABLE SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Medium-Voltage Power Cable:
1. Measurement: Length of installed cable.
  2. Payment: Linear foot prices offered in the Price Schedules.
- B. Medium-Voltage Power Cable Accessories:
1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

- A. Association of Edison Illuminating Companies (AEIC)
1. AEIC CS8-13 Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV
- B. ASTM International (ASTM)
1. ASTM B496 - 16 Compact Round Concentric-Lay-Stranded Copper Conductors
- C. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE 48-2009 Alternating-Current Cable Terminations 2.5 kV Through 765 kV
  2. IEEE C2-2017 National Electrical Safety Code (NESC)
- D. National Electrical Manufacturers Association (NEMA)
1. ICEA S-93-639 NEMA WC 74-2012 5-46 KV Shielded Power cable for Use in the Transmission and Distribution of Electric Energy
- E. National Fire Protection Association (NFPA)
1. NFPA 70-2017 National Electrical Code (NEC)
- F. Underwriter's Laboratory (UL)
1. UL 486A-486B-2013 Wire Connectors

### **1.03 PERFORMANCE REQUIREMENTS**

- A. Furnish, install, and make operable 15-kV cable systems.
- B. Determine actual cable length and cable termination configurations.

### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 05 13-1, Approval Drawings and Data:
  - 1. Manufacturer's catalog data.
- C. RSN 26 05 13-2, Field Test Reports.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver cable on reels which are sufficiently sturdy to withstand normal handling during shipping, hauling, and installation.
- B. Seal ends of cable on reels from moisture with suitable heat-shrinkable caps and mastic compounds.
- C. Do not drag cable across ground, fences, or other sharp projections during shipping or placement of cable reels at jobsite.

## **PART 2 PRODUCTS**

### **2.01 POWER CABLE**

- A. Type: MV-105 single-conductor shielded.
- B. Ratings:
  - 1. Rated Voltage: 5 kilovolts.
    - a. Operating voltage: 4.160 kilovolts.
    - b. Frequency: 60-hertz.
    - c. Operating temperature: 105 degrees C, maximum.
    - d. Insulation level: 133 percent insulation.
- C. Conductor:
  - 1. Stranded bare annealed copper in accordance with ASTM B496.
  - 2. Size: As shown.

- D. Insulation: Solid-dielectric EPR (ethylene-propylene rubber).
- E. Screens:
  - 1. Strand Screen: Extruded, semi-conducting EPR.
  - 2. Insulation Screen: Extruded, semi-conducting EPR strand screen applied directly over the insulation.
- F. Shield: 5 mil copper tape, coated, helically applied.
- G. Jacket: PVC (polyvinyl chloride).
- H. Suitable for conduit installation.
- I. Date of Manufacture: No more than 24-months before Notice-to-Proceed.
- J. Have AWG or circular mil designation.
- K. Conform to ICEA S-93-639 NEMA WC 74 and AEIC CS8, where applicable.

## **2.02 CABLE TERMINATIONS**

- A. Type: Kit form, heat shrinkable, suitable for outdoor use and with cable specified. Include stress tube, ground kit, and appropriate lug.
- B. Conform to IEEE 48.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. In accordance with manufacturer's instructions and recommendations, and recognized industry practice.
- B. Install cable terminations in accordance with manufacturer's instructions and recommendations.
- C. Reel Procedures:
  - 1. Remove cable from reel by turning mounted reel.
  - 2. Do not end feed from reel.
  - 3. Do not allow cable reel to rest upon reeled cable.
  - 4. Inspect cable as removed from reel for visible defects.
- D. Do not drag cable across ground, fences, or other sharp projections.

- E. Installation in Raceways:
  - 1. Do not exceed cable pulling tensions and bending radius recommended by manufacturer.
  - 2. Use lubrication in accordance with manufacturer's recommendations.
  - 3. Pull cable by hand, or use tensiometer or release mechanism on cable pulling equipment to ensure pulling tension remains below tensile strength of cable.
  - 4. Pull all cable in each conduit run at the same time.
- F. Terminate or seal cut ends of cable immediately after cutting operation. Seal ends of cable against moisture with waterproof end caps.
- G. Do not splice cables.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Perform testing after cable terminations have been installed, but before connections have been made to bus or apparatus.
- B. Notify COR, in writing, of date, time, and cables to be tested at least 14 working days before testing. Test dates shall be mutually agreeable between Contractor and COR.
- C. Perform Following Tests:
  - 1. Insulation resistance.
  - 2. DC high potential.
- D. Insulation Resistance Test:
  - 1. Perform test prior to DC high potential test.
  - 2. Measure cable insulation resistance with megohm meter.
  - 3. Test voltage: 1,000 volts direct current.
  - 4. Reject cable if resistance is less than 25 megohms.
- E. DC High Potential:
  - 1. Test voltage: 28 kilovolts.
  - 2. Apply voltage between conductor and metallic shield with the shield and other metallic components of the cable grounded.
  - 3. Initially applied DC voltage shall not exceed 3 times rated AC voltage of cable.
  - 4. Test duration: 15-minutes or until current reading levels off and remains steady for at least 3-minutes.
  - 5. Test failure is detected by excessive leakage current tripping internal circuit breaker of test equipment.

- F. Record the following data on test report for each test performed and for each conductor tested:
1. Date of test.
  2. Name or names of Contractor's personnel who performed test.
  3. Name of Government inspector who witnessed test.
  4. Conductor identification.
  5. Test data for each conductor tested:
    - a. Provide actual resistance values measured in ohms. Use of "Pass", "Fail", check marks, or infinity symbol are not acceptable.
    - b. Record current magnitude at 2-, 5-, 10- and 15-minutes after maximum test voltage has been reached.
  6. Overall result of test: Pass or Fail.

**END OF SECTION**

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**SECTION 26 05 20**  
**GROUNDING AND BONDING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Ground Cable:

1. Measurement: Length of ground cable installed.
2. Payment: Linear foot prices offered in the Price Schedules:
  - a. Includes costs of associated accessories.

B. Ground Rods:

1. Measurement: Number of ground rods installed.
2. Payment: Ground rod unit prices offered in the Price Schedules:
  - a. Includes costs of associated accessories.

C. Electrical Ground Resistance Test:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |                       |  |
|----|-----------------------|--|
| 1. | ASTM B3 - 13          | Soft or Annealed Copper Wire   |
| 2. | ASTM B8 - 11(2017)    | Concentric-Lay-Stranded Copper<br>Conductors, Hard, Medium-Hard, or Soft |
| 3. | ASTM B228 - 11a(2016) | Concentric-Lay-Stranded Copper-Clad Steel<br>Conductors                  |

B. Institute of Electrical and Electronic Engineers (IEEE)

- |    |               |  |
|----|---------------|--|
| 1. | IEEE 80-2000  | Safety in AC Substation Grounding  |
| 2. | IEEE 81-2012  | Measuring Earth Resistivity, Ground<br>Impedance, and Earth Surface Potentials of<br>a Ground System |
| 3. | IEEE 142-2007 | Grounding of Industrial and Commercial<br>Power Systems  |
| 4. | IEEE 837-2017 | Qualifying Permanent Connections Used in<br>Substation Grounding                                     |
| 5. | IEEE C2-2017  | National Electrical Safety Code (NESC)   |

- C. National Fire Protection Association (NFPA)
  - 1. NFPA 70-2017 National Electrical Code (NEC)
- D. Underwriters Laboratories (UL)
  - 1. UL 467-2013 Grounding and Bonding Equipment

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 05 20-1, Approval Drawings and Data:
  - 1. Manufacturer's catalog data.
- C. RSN 26 05 20-2, As-built Drawings:
  - 1. Specifications drawings indicating as-built changes made to grounding systems.
- D. RSN 26 05 20-3, Test Reports.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Ground Cable:
  - 1. Annealed bare-copper cable:
    - a. ASTM B8, class B.
    - b. Solid wires used in forming copper cable: ASTM B3.
  - 2. Copper-clad steel cable: ASTM B228.
  - 3. Concentric stranded.
  - 4. Sizes:
    - a. As indicated on drawings.
    - b. Where not shown, minimum sizes:
      - 1) Ground risers and electrode conductors: 4/0 AWG.
      - 2) Equipment grounding conductors:
        - a) Major equipment: Equal in size to electrode conductors.
        - b) Minor equipment: 4 AWG.
      - 3) Electrode interconnecting conductors: Equal in size to electrode conductors.

**B. Ground Rods:**

1. Type: Solid, copper-clad steel:
  - a. Bond 0.010-inch thick layer of copper inseparably to steel core.
2. Length: 10-feet.
3. Diameter: 3/4-inch, nominal.
4. In accordance with UL 467.

**2.02 ACCESSORIES****A. Cable Connectors:**

1. Welded or bolted solderless type.
2. Current-carrying capacity: Equal to cable with which they are used.
3. Connectors for ground cables, including fittings, lugs, bolts, nuts, and washers: Copper alloy containing not more than 4 percent zinc.
4. Bolted solderless type connectors: IEEE 837.
5. Ground connectors that will be direct buried or embedded in concrete: Listed for direct burial use in accordance with requirements of UL 467.

**B. Ground Plates:**

1. High-strength, high-conductivity, cast-copper alloy.
2. Four-hole type, except where indicated on drawings.
3. Suitable for concrete construction.

**C. Flexible Copper Braid:**

1. Flat, extra flexible, tinned, pure copper braid.
2. Un-plated, seamless, pure copper ferrules formed into a rectangular shape on each end.
3. Outdoor ampacity: 400 amperes, minimum.
4. Overall length: Suitable for application.

**2.03 WELDING PROCESS****A. Use Cadweld, Thermoweld, or equivalent exothermic process.****B. Molds and Weld Metal:**

1. Use fresh stock from same manufacturer.
2. Weld metal and starting material: No significant quantities of hazardous ingredients.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with NFPA 70, IEEE C2, and this Section.
- B. Make grounding connections in accordance with standard drawings 40-D-4334, 40-D-4335, and 40-D-4753; and as shown.
- C. Use at least 4 AWG stranded bare copper as equipment grounding conductors.
- D. Do not connect equipment grounding conductors directly to steel reinforcing bars.
- E. Ground or Bond as applicable:
  - 1. Electric motors.
  - 2. Metal enclosures for electrical equipment.
  - 3. Unit substations.
  - 4. Elevated steel tanks.
  - 5. Regulating tanks.
  - 6. Air chambers.
  - 7. Shielding and armor on insulated conductors.
  - 8. Steel structural columns.
  - 9. Pumping plant service yard fence.
  - 10. Metal structures located within 200-feet of power or distribution line centerlines.
- F. Grounding Electrodes at Pumping Plant:
  - 1. Use steel reinforcing bar system within concrete floor at bottom of sump as grounding electrode:
    - a. Steel reinforcing bars used for electrodes:
      - 1) Diameter, minimum: 1/2-inch.
      - 2) Length, minimum: 20-feet.
      - 3) Concrete encasement, minimum: 2-inches thick.
  - 2. Ground risers:
    - a. Connect grounding electrodes to ground bus.
    - b. Install at least 6 ground risers for connection to grounding electrodes, unless shown otherwise.
  - 3. Ground bus:
    - a. Embed in floor of structure.

- b. Connect equipment grounding conductors, grounding system risers, and building structural steel to ground bus.
  - 4. Ground ring:
    - a. Attach to ground rods to serve as grounding electrode for water storage tanks.
    - b. Encircle each tank completely.
    - c. Bury in direct contact with earth.
    - d. Depth: Not less than 2 1/2-feet.
    - e. Conductor: At least 20-feet of 4/0 AWG stranded bare copper.
- G. Service Yard Fence:
  - 1. Ground service yard fence, gate posts, and gate frames.
  - 2. Ground fence fabric on each side of corner post or location where fabric is not continuous.
- H. Ground Electrode Interconnections:
  - 1. Install minimum of two physically separate grounding electrode tie conductors as interconnections between ground electrodes of pumping plant ground system and elevated steel tank as shown.
  - 2. Installation depth: At least 2 1/2-feet.
  - 3. Separation: At least 10-feet.
- I. Ground Rods:
  - 1. Drive ground rods vertically until tops of rods are within 2-inches above installation location of ground cables to which rods will be connected.
  - 2. If solid rock is encountered within 3-feet of subgrade, grout ground rod into 1 1/4-inch vertical hole such that top of rod is within 2-inches above installation location of ground cables to which rod will be connected.
  - 3. If solid rock is encountered deeper than 3-feet below subgrade, drive ground rod to refusal at approximately 45 degree angle, then bend ground rod horizontally such that top of rod is within 2-inches above installation location of ground cables to which rod will be connected.
- J. Connections:
  - 1. Make all ground connections between equipment, miscellaneous metalwork, and ground plates whether or not such grounding connections are shown.
  - 2. Number of grounding connections for equipment may be one, two, or more in some cases.
  - 3. Remove paint, enamel, scale, oil, grease, or other foreign nonconductive material from point of contact on metal surfaces before making ground connections.

4. Repair damaged or removed paint or galvanizing material on metal finishes.
  5. Make ground connections that are direct buried or embedded in concrete using an exothermic process and in accordance with manufacturer's instructions:
    - a. In accordance with manufacturer's instructions.
    - b. Inspect in accordance with pocket handbook *A7D Installers and Inspectors Guide for CADWELD® Electrical Connections* written by ERICO® Products, Inc., Cleveland, Ohio.
    - c. Remove and replace rejected connections.
- K. Excavate, place, and compact backfill in accordance with Sections 31 23 10 – Earthwork and 31 23 02 – Compacting Earth Materials, respectively.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Test Resistance of Grounding System:
1. Notify COR in writing at least 3 working days in advance of time of test in order that test may be witnessed by COR.
  2. Perform test no sooner than 30-days after completion of structural concrete work.
  3. Measured resistance: Less than 5 ohm.
  4. Use fall of potential method in accordance with section 8.2.1.5 of IEEE 81.
  5. Testing device:
    - a. Earth resistance tester:
      - 1) Heavy-duty, low-resistance type with direct-reading and direct-current ohmmeter as described in bulletin No. 25 and any one of bulletins Nos. 25J, 25J-2, and 25T, all by James G. Biddle Company; 3 point electronic Vibroground® by Associated Research, Incorporated; or equal.
      - 2) Capable of measuring ground resistance to an accuracy of 0.5 ohms or better.
  6. Test performance:
    - a. Initial distance between remote current electrode (C) and grounding system under test (X): At least six times longest diagonal dimension of grounding system.
    - b. Distance between electrode C and electrode X if grounding electrode system consists of one or two ground rods: At least 100-feet or as directed by COR.
    - c. Beginning at electrode X, drive potential-reference electrode (P) into ground at a number of test points on a straight line between electrode X and electrode C.

- d. Distance between test points: Approximately 5 percent of actual distance between electrodes X and C.
- e. Continuously log apparent resistance readings for each test point and plot curve of resistance versus distance to ensure that electrode C location is giving acceptable results as indicated in IEEE 81.
- f. Measure and record test points until reaching electrode C or as directed by COR. If plot of resistance -vs- distance curve indicates remote current electrode is in area of influence of grounding system, increase distance between electrode C and grounding system, and measure and record new set of test data.
- g. Allow 40 calendar days after receipt of grounding system resistance test reports for Government to determine location and size of any additional grounding is required.
- h. Retest grounding system resistance in accordance with these paragraphs if additional grounding is added.

**END OF SECTION**

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**SECTION 26 05 33**  
**RACEWAYS AND BOXES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Electrical Conduit:
1. Measurement: Length of installed conduit.
  2. Payment: Linear foot prices offered in the Price Schedules for applicable conduit:
    - a. Includes cost of work and materials for conduit.
- B. Fabricated Sheet Steel Boxes, Wiring Troughs, and Precast Handholes:
1. Payment: Lump sum prices offered in the Price Schedules:
    - a. Includes cost of drilling and punching holes.

**1.02 REFERENCE STANDARDS**

- A. American National Standards Institute (ANSI)
1. ANSI C80.1-2005                      Electric Rigid Steel Conduit (ERSC)
  2. ANSI/SCTE 77-2010                Specification for Underground Enclosure Integrity
- B. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE C2-2017                        National Electrical Safety Code (NESC)
- C. National Electrical Manufacturers Association (NEMA)
1. NEMA 250-2014                      Enclosures for Electrical Equipment (1,000 Volts Maximum)
  2. NEMA FB 1-2014                    Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
  3. NEMA RN-1                            Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
  4. NEMA TC 2-2013                    Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
  5. NEMA TC 3-2013                    Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
- D. National Fire Protection Association, Inc. (NFPA)

- |   |              |  |
|---|--------------|--|
| 1.                                      | NFPA 70-2017 | National Electrical Code (NEC)         |
| E. Underwriters Laboratories, Inc. (UL) |              |  |
| 1.                                      | UL 360-13    | Liquid-tight Flexible Steel Conduit    |
| 2.                                      | UL 6         | Electrical Rigid Metal Conduit – Steel |
| 3.                                      | UL 651-11    | Schedule 40 and 80 Rigid PVC Conduit   |

### **1.03 DESIGN REQUIREMENTS**

- A. Determine/verify size of junction and pull boxes, fabricated sheet steel boxes, and precast handholes in accordance with NFPA 70.
- B. Determine/verify size of wiring trough in accordance with NFPA 70.

### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 05 33-1, Approval Drawings and Data:
1. Manufacturer’s drawings and catalog data.
- C. RSN 26 05 33-2, As-built Drawings:
1. Marked prints of specifications drawings indicating “As-built” changes made to electrical raceways during construction.

## **PART 2 PRODUCTS**

### **2.01 RACEWAYS**

- A. Plastic Coated Rigid Steel (PCRS):
1. Conduit conforms to ANSI C80.1, UL6 and NEMA RN-1.
- B. Rigid Metal Conduit (RMC):
1. ANSI C 80.1.
- C. Rigid Polyvinyl Chloride Conduit (PVC):
1. Product Description: Schedule 80 PVC conduit. Conduit and elbows furnished with integral bell end.
  2. Length: Manufacturer’s standard 10- or 20-foot lengths.
  3. Temperature Rating: Equal to or greater than temperature rating of enclosed conductors.
  4. Conduit conform to NEMA TC 2, NFPA 70, and UL 651. Fittings and conduit bodies conform to NEMA TC 3, NFPA 70, and be UL listed.

- D. Liquidtight Flexible Metal Conduit (LFMC):
1. Interlocked steel construction with PVC jacket.
  2. Ultra-violet resistant.
  3. Color: Black.
  4. Conform to NFPA 70 and UL 360.
  5. Fittings conform to NEMA FB 1.
- E. Wiring Trough:
1. Material: 16 gauge or 14 gauge galvanized steel.
  2. Enclosure:
    - a. NEMA Type 3R in accordance with NEMA 250.
    - b. Drip shield top and no knockouts.
  3. Slip-on removable cover fastened with captive screws along bottom edge and provided with provisions for padlocking.
  4. Embossed mounting holes on back of enclosure.
  5. Finish: Manufacturer's standard grey coating inside and outside of enclosure.

## **2.02 OUTLET BODIES, DEVICE BOXES, JUNCTION AND PULL BOXES**

- A. Outlet Bodies and Fittings:
1. Material: Cast iron or malleable iron.
  2. Covers: Cast or sheet metal.
- B. Cast Devices Boxes: Type FD and GRF manufactured by Cooper Crouse-Hinds; or equal, having the following essential characteristics:
1. Rectangular or round, deep-wiring device outlet boxes with threaded hub connections for rigid steel conduit.
  2. Material: Iron alloy.
  3. Number of gangs: As required.
  4. Provide plugs for unused openings.
  5. Extension rings: Iron alloy with corrosion-resistant finish.
- C. Boxes for Dry Wall Construction:
1. Standard galvanized sheet steel switch and outlet boxes.
  2. Switch boxes:
    - a. Depth: 2 1/8-inches, minimum.
    - b. Number of gangs: As required.
    - c. Furnish with raised device covers (plaster rings).

- D. Fabricated Sheet Steel Boxes:
1. Used as junction and pull boxes.
  2. Sheet steel thickness: No. 14 United States Standard gauge, minimum.
  3. Boxes installed in pumping plant building to be NEMA type 12. Boxes installed in chemical building to be NEMA type 4X. Boxes installed outdoors to be NEMA type 4.
  4. Hinged cover with oil-resistant gasket.
  5. Finish: Manufacturer's standard grey coating.
  6. Conform to NEMA 250.
- E. Large, Fabricated Sheet Steel, Free Standing, Type 4 Enclosures:
1. Large free-standing pull box, NEMA 250, Type 4.
  2. Sheet steel: 12-gauge, minimum.
  3. Seams: Continuously welded and ground smooth.
  4. Coating: Polyester powder coating over phosphatized surface, inside and out, ANSI 61 gray.
  5. Internal mounting channels welded horizontally to sides at top, bottom, and center.
  6. Stainless-steel door clamps and heavy gauge continuous hinge with stainless-steel pin.
  7. Includes lifting eyes, document pocket, and oil resistant door gasket.
  8. Size in accordance with NFPA 70 or as indicated on drawings.

### **2.03 PRECAST HANDHOLE**

- A. Type: Precast polymer concrete with open bottom and Tier 15 rating.
- B. Cover:
1. Bolt down type with gasket and stainless-steel bolts.
  2. Tier level rating embossed on the surface.
  3. Electrical pull box: Embossed logo "ELECTRIC" on the surface.
  4. Communication pull box: Embossed logo "OPTICAL FIBER" on surface.
- C. Provide embedded pulling eyes with ratings suitable for installation. Locate pulling eyes on wall opposite each conduit entrance.
- D. Conform to test provisions of ANSI/SCTE 77.

## 2.04 CONDUIT FITTINGS

- A. Expansion-deflection Couplings:
1. Furnish for movement in any direction.
  2. Watertight, raintight, concrete tight.
  3. Deflection and expansion: 3/4-inch, minimum.
  4. Angular misalignment: 30 degrees, minimum.
- B. Watertight Conduit Hubs:
1. Myers hub manufactured by Cooper Industries, Crouse-Hinds Division, Syracuse, NY, catalog series ST-, STA- and SSTG-; catalog series HUB- and HUBG- manufactured by Appleton, Rosemont, IL; catalog series CHM- manufactured by O-Z Gedney, Rosemont, IL; or equal with the following essential characteristics:
    - a. Suitable for terminating rigid steel electrical conduit through the walls of enclosures.
    - b. Recessed O-ring for raintight connection.
    - c. In accordance with NEMA FB-1.
    - d. Galvanized malleable iron.
    - e. Insulated throat.

## 2.05 ACCESSORIES

- A. Fittings required to complete electrical conduit systems. Includes, caps, connectors, couplings, unions, nipples, reducers, elbows, pipe plugs, bondnuts, and any other fittings.
- B. Devices required to fasten, clamp, attach, and support conduit in place. Includes supports and clamps complete with bolts, washers, and nuts.
- C. Locknuts and Bushings:
1. Locknuts: Steel. Die cast locknuts are not acceptable.
  2. Bushings: Insulated and pressure cast or malleable iron. Grounding bushing to be lay-in saddle type.
- D. Conduit Riser Grips:
1. Suitable to support vertical cable runs in rigid steel conduit.
  2. Single weave closed or split mesh type.
  3. Mesh material: Tin-coated bronze strands.
- E. Conduit Tags: Round brass or stainless-steel.
- F. Polyethylene Warning Tape:
1. Type: Heavy-duty polyethylene, detectable underground warning tape.
  2. Width: 6-inches.

3. Color: Red.
  4. Copy: Continuously imprinted with "CAUTION BURIED ELECTRIC LINE BELOW" or equivalent wording.
  5. Suitable for direct burial.
- G. Thread Lubricant: Lithium, graphite, or zinc-based material designed to inhibit corrosion and to lubricate metal-to-metal joints.
- H. Electrical duct seal for sealing ends of raceways.
- I. Protective Sealant: Water repellent, and resistant to peeling and cracking.
- J. PVC Solvent Cement: In accordance with NEMA TC 2 and conduit manufacturer's recommendations.
- K. Corrosion Protection Tape:
1. Scotchrap™ 51 All-Weather Corrosion Protection Tape manufactured by 3M, St. Paul, MN, and Plymouth Plywrap 11 Vinyl Pipe Wrap manufactured by Plymouth Rubber Company, Canton, MA; or equal, having the following essential characteristics:
    - a. Thickness: 20 mils minimum.
    - b. Material: Polyvinyl chloride (PVC).

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Conduit Type: As listed below unless shown otherwise:
1. PVC Conduit: For direct-buried conduit inside and outside the fenced pumping plant yard.
  2. PVC Conduit: For conduit installed beneath concrete slab floors.
  3. PRCS Conduit: For exposed conduit inside the chemical building.
  4. Rigid Metal Conduit: Exposed conduit, unless shown otherwise. Vertical risers through concrete slab floor.
- B. Install as shown and in accordance with NFPA 70 and IEEE C2.
- C. Determine routing of exposed, buried, and embedded conduit when not shown.
- D. Determine exact location of embedded conduit stub-ups based on equipment being furnished.
- E. Bends:
1. Make smooth, gradual bends to permit pulling insulated conductors without undue stress or damage to conductors or conduit.

2. Ensure bends are free from kinks, indentations, or flattened surfaces.
  3. Make metal conduit bends onsite with radii in accordance with NFPA 70.
  4. Bend conduit cold to prevent damage to protective coating.
- F. Remove burrs and sharp corners at ends of metal conduit.
- G. Coat male threads of rigid metal conduit joints with suitable graphite or zinc sealing material before making joints.
- H. Tighten conduit joints securely to ensure electrical continuity and to prevent entrance of moisture or foreign material.
- I. Install with necessary fittings and supports.
- J. Make transitions from PVC conduit to RMC with suitable fittings designed for application.
- K. Tighten conduit to electrical equipment mounted on tubular metal structures securely and support rigidly in place by conduit clamps, hex head nuts, and threaded 3/8-inch stud fasteners driven by powder-actuated tools.
- L. Install expansion couplings where exposed or embedded conduits cross expansion or contraction joints. Install expansion couplings and expansion-deflection couplings in accordance with manufacturer's instructions.
- M. Conduit for Fire Protection System:
1. Conduit shall be dedicated to fire protection system. Wiring for fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of other systems.
  2. See Section 28 31 00 – Fire Detection and Alarm for additional information.
- N. Exposed Conduit Runs:
1. Straight and parallel with each other and with centerlines of room or structure.
  2. Support conduit rigidly in place and in accordance with NFPA 70. Do not weld conduit to conduit supports or structural steel.
- O. Conduit Beneath Concrete Slab Floors:
1. Transition horizontal runs of PVC conduit to rigid metal conduit before making 90-degree bends using appropriate conduit fitting.
  2. Make 90-degree bend with rigid metal conduit and extend vertically through concrete slab floor. Ensure conduit risers are vertically plumb.
  3. Wrap rigid metal conduit with anti-corrosion tape from transition coupling to at least 6-inches above concrete slab floor.
  4. Apply manufacturer's recommended pipe primer to rigid metal conduit before wrapping with corrosion tape.

5. Apply anti-corrosion tape in accordance with manufacturer's instructions and recommendations.
6. Make adequate provisions to protect anti-corrosion tape wrap from physical damage during backfill operations.

P. Conduit Embedded in Concrete:

1. Conduit to be rigid steel (RMC) type.
2. Conduit not to displace more than 3 percent of gross area of cross-section of slab (Calculate cross sectional area as 12-inches times slab thickness).
3. Conduit outside diameter to be no larger than 1/3 of overall thickness of slab in which they are embedded.
4. Conduit to be spaced at least 3 diameters or widths on center.
5. Conduit to occupy middle third of cross-sectional depth of slab in which they are embedded, where possible.
6. Protect ends of conduit with coupling and plug to prevent entrance of concrete, sand, or other foreign material.
7. Tie conduit from reinforcing bars or otherwise support to prevent sagging while concrete is being placed.
8. Conduit stub-ups:
  - a. Minimum length above finished floor: 4-inches, not including coupling.
  - b. Terminate conduit with coupling and plug until ready to connect remaining conduit sections. Replace plug with bushing or Chase-type nipple before installing insulated conductors.
  - c. Approximately 1-foot of horizontal embedded conduit and entire vertical stub-up to be plastic-coated rigid steel conduit.
9. Seal conduit boxes with rubber gasketed blank cover. Clean concrete from inside of conduit boxes immediately after forms are removed.
10. Swab conduit within 24-hours after removal of forms with clean dry rags until conduit is thoroughly cleaned and dried.
11. Terminate ends of conduit that do not terminate at boxes with couplings and pipe plugs or insulating bushings and caps.

Q. Direct-Buried Conduit:

1. Depth: 24-inches, minimum unless shown otherwise.
2. Install 2-inches of sand around conduit.
3. Install detectable warning tape 18-inches above buried conduit.
4. Backfill and compact trench in accordance with Section 31 23 22 – Pipe Trench Earthwork.

R. Liquid tight Flexible Metal Conduit:

1. Use flexible conduit for connections to equipment that is subject to vibration, where flexibility is required, or where shown.
2. Maximum length of a flexible conduit section is not to exceed 24-inches.

E. Hand Holes:

1. Install in locations shown and in accordance with manufacturer's instructions and recommendations.
2. Place a minimum of 6-inches of pea gravel or crushed rock in bottom of excavation before installing hand hole.
3. Install such that top of hand hole is at finished grade level.
4. Backfill and compact around hand hole in accordance with Section 31 23 10 – Earthwork and as directed by COR.

S. Conduit Terminations:

1. Make conduit terminations to indoor boxes, cabinets, and panel boards in accordance with standard drawing 104-D-254.
2. Make conduit terminations to outdoor boxes with watertight conduit hubs. Use of locknuts, bushings, or bushed nipples at outdoor conduit terminations is not acceptable.
3. Install bushings or Chase-type nipples on ends of conduit to protect insulation of insulated conductors from abrasion.
4. Install locknuts and bond nuts to provide tight ground connections between conduit and boxes, panel boards, and cabinets.
5. Make terminations of conduit beneath substation switchgear, motor control equipment, motor control centers, and floor mounted cabinets with grounding bushings. Connect grounding bushing to equipment ground bus with a 4 AWG bare-copper conductor.
6. Seal ends of conduit terminations with electrical duct seal to prevent air circulation and entrance of vermin through conduits into boxes, panel boards, or cabinets. Install duct seal to a minimum depth of 1-inch.

T. Conduit Tags:

1. Provide metal conduit tags for conduit terminations.
2. Stamp or engrave tag with conduit number as shown on "As-Built" cable and conduit schedule.
3. Permanently attach tag to conduit with wire and metal crimp-type connector.

**END OF SECTION**

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**SECTION 26 05 36**  
**CABLE TRAYS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cable Trays:

1. Measurement: Length of installed cable tray.
2. Payment: Linear foot prices offered in the Price Schedules for applicable cable tray:
  - a. Includes cost of work and materials for cable tray.

**1.02 REFERENCE STANDARDS**

A. Aluminum Association (AA)

1. AA ADM – 2010 Aluminum Design Manual

B. American Institute of Steel Construction (AISC)

1. AISC 316-89 Manual of Steel Construction - Allowable Stress Design - 9th Edition

C. ASTM International (ASTM)

1. ASTM A123/A123M-09 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. ASTM A153/A153M-09 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. ASTM A385/A385M-09 Providing High-Quality Zinc Coatings (Hot-Dip)
4. ASTM A563-07A Carbon and Alloy Steel Nuts
5. ASTM A780/A780M-09 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
6. ASTM F844-07A Washers, Steel, Plain (Flat), Unhardened for General Use

D. American Welding Society, Inc. (AWS)

1. AWS D1.1/D1.1M-10 Structural Welding Code – Steel
2. AWS D1.2/D1.2M-03 Structural Welding Code - Aluminum

E. National Electrical Installation Standards (NEIS)

1. NEIS 105 – 2007 Installing Metal Cable Tray Systems
- F. National Electrical Manufacturers Association (NEMA)
1. NEMA VE 2 – 2013 Cable Tray Installation Guidelines
- G. National Fire Protection Association (NFPA)
1. NFPA 70 - 2014 National Electrical Code (NEC)

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and data.
- B. RSN 26 05 36-1, Approval Drawings:
1. Show plan, elevations, and typical cross-sections of cable tray system, with overall dimensions and weights.
  2. Show locations and types of cable tray supports for both horizontal and vertical run cable trays.
  3. Show typical connection and splice details.
- C. RSN 26 05 36-2, Approval Data:
1. Manufacturer's Product Data:
    - a. Cable trays, fittings, and accessories.
    - b. Supports and hardware.
    - c. Certification that the cable tray system meets the specified requirements.

### **1.04 QUALIFICATION OF WELDERS**

- A. Qualify welders in accordance with AWS D1.1 and D1.2 using procedures, materials, and equipment of type required for work.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Protect from corrosion, deformation, and other types of damage.
- B. Store items in an enclosed area free from contact with soil and weather.
- C. Remove and replace damaged items with new items.

## PART 2 PRODUCTS

### 2.01 MATERIALS

#### A. Cable Trays, Fittings, and Accessories:

1. Aluminum or Aluminum Alloy cable trays and accessories as manufactured by Cooper B-Line, Highland IL 62249; Cablofil, PW Industries, Mascoutah IL 62258; or equal, having the following essential characteristics:
  - a. Cable trays and fittings:
    - 1) Formed channel sides or channel with binding strip so there are no sharp edges or projections.
    - 2) Type: As shown:
      - a) Ladder with rungs at 9-inch maximum spacing.
        - i. Rungs: 1-inch-wide channels, minimum.
      - b) Channel/Solid Bottom Type.
    - 3) Side height, minimum: As shown.
    - 4) Widths: As shown.
    - 5) Cable Load: 15 to 20 pounds per lineal foot, minimum.
    - 6) Fitting radius: 12-inches minimum, unless otherwise shown on drawings.
    - 7) Allowable tray deflection: 1/180 of span between supports, maximum, when tray is loaded with manufacturer's design load.
    - 8) Spacing between vertical run supports: 5-feet maximum.

#### B. Cable Tray Supports: Bracket- or trapeze-type, or combination of both.

1. Bracket-Type:
  - a. Brackets: Brackets equal to Globe Strut No. G-5040; Unistrut Corp. No. P2544; Cooper B-Line Systems No. 297; or equal, having the following essential characteristics:
    - 1) Cantilever or braced.
    - 2) Length: As required to support selected cable tray.
    - 3) Single-channel or double-channel as required.
    - 4) Channel: 1 5/8-inch-wide by 1 5/8-inch-deep with 7/8-inch opening.
    - 5) Finish:
      - a) Galvanized after fabrication, or
      - b) Fabricate brackets from material that is coated with 1.25 ounce/ft<sup>2</sup> of zinc in accordance with ASTM A123 and A385.

2. Trapeze-Type:
  - a. Threaded rods, screws, clamps, nuts, and washers:
    - 1) Threaded rods: Material and size to be determined by cable tray manufacturer.
    - 2) Screws: As recommended by cable tray manufacturer.
    - 3) Clamps: As recommended by cable tray manufacturer.
    - 4) Nuts: ASTM A563.
    - 5) Washers: ASTM F844 (unhardened for general use).
    - 6) Finish: Hot-dip galvanized.

C. Arc-Welding Electrodes:

1. Filler metal and required shielding gases or fluxes: AWS D1.1.
2. Filler metal for steel: Minimum tensile strength of 70,000 pounds-per-square-inch (psi).

## 2.02 FABRICATION

- A. Fabricate metalwork in accordance with AISC 316, AA ADM, and these specifications.
  1. Perform welding and related work in accordance with AWS D1.1 and AWS D1.2.
- B. If straightening is necessary, use methods that will not injure metal.
- C. Galvanizing:
  1. After shop work completion and before galvanizing, if required, clean material of rust, loose scale, dirt, oil, grease, slag from welded areas, and other foreign substances.
  2. Galvanize items of metalwork as specified or shown on drawings. Use hot-dip galvanizing, where required after fabrication, in accordance with ASTM A123 and ASTM A385.
  3. Galvanize threaded rods, screws, clamps, nuts, and washers in accordance with ASTM A153. Remove excess spelter by centrifugal spinning.
  4. Fabricator's Galvanizing Repair:
- D. Repair in accordance with Section 09 96 20 – Coatings.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Where locations and dimensions of cable trays shown on drawings are tentative or subject to change dependent upon equipment furnished, confirm locations and dimensions prior to fabrication of cable tray system.

### **3.02 INSTALLATION**

- A. Install cable tray system at locations and elevations shown on drawings and in accordance with manufacturer's instructions.
- B. Ensure that supports for cable tray system are properly attached to structural framing members of metal building system.
- C. Install cable tray system in accordance with NEIS 105 and NEMA VE 2.
- D. Ground cable tray system in accordance with NFPA 70.
- E. Segregate instrumentation and power cables using appropriate accessory barrier strips.
- F. Cable tray to equipment/enclosure transitions shall be made using conduit or appropriate box connectors:
  - 1. Ensure equipment integrity is maintained to prevent entrance of foreign material.
- G. Galvanizing Repair:
  - 1. Repair in accordance with Section 09 96 20 – Coatings.
- H. Painting:
  - 1. Paint surfaces of miscellaneous metalwork exposed after installation, except galvanized steel, in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

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**SECTION 26 05 90**  
**WIRING CHECKOUT AND TESTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for equipment and devices that require wiring checkout and tests.

**1.02 REFERENCE STANDARDS**

- A. National Fire Protection Association (NFPA)
1. NFPA 70- 2014 National Electrical Code (NEC)

**1.03 DEFINITIONS**

- A. Qualified Person: In accordance with Article 100 of NFPA 70.

**1.04 PERFORMANCE REQUIREMENTS**

- A. Tests:
1. Demonstrate proper interaction between equipment through cabling interconnections and verify these interconnections are accurately documented.
  2. In addition to tests required by Section 26 05 10 – Conductors and Cables.
- B. Furnish materials, including test instruments, required for checkout and testing.
- C. Make wiring changes and drawing revisions to ensure there are no discrepancies between check prints, and internal equipment wiring and external cabling.
- D. Replace defective equipment and make device setting adjustments as required for operation of electrical systems in accordance with specifications and manufacturer's instructions.
- E. If required during testing, remove and replace wire connections.
- F. Make wiring changes, wire tag revisions, and other repairs or revisions during testing session when discrepancy is discovered.
- G. Perform wiring checkout, and operational and functional tests in presence of COR.

## **1.05 QUALIFICATIONS**

### **A. Testing Personnel:**

1. Competent and qualified person to perform wiring checkout, and operational and functional testing.
2. Have thorough knowledge of electrical equipment, installation, and drawings.
3. Qualified to operate equipment being tested.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 FIELD QUALITY CONTROL**

- A. Notify COR in writing 10-days in advance of each testing session.
- B. Provide the following at time wiring checkouts and tests are performed:
  1. Two complete sets of full-size (D-size) electrical schematic and wiring diagram check prints for equipment being tested:
    - a. One set to be used and maintained by COR.
    - b. One set to be maintained by Contractor and used to produce final drawings.
- C. Perform wiring checkout and tests in accordance with the following:
  1. Wiring checkout:
    - a. Use electrical schematic and wiring diagram check prints to perform internal wiring check of equipment.
    - b. Use electrical schematic and wiring diagram check prints to perform wiring check of external cabling.
    - c. Perform a complete wire-by-wire, contact-by-contact, terminal-by-terminal (point-to-point) check of circuit logic.
    - d. Verify agreement with approved wiring diagrams. Revise to reflect circuit logic corrections made during checkout.
    - e. Verify agreement with approved schematic diagrams. Revise to reflect circuit logic corrections made during checkout.
    - f. Verify contact configuration and contact numbering.
    - g. Verify continuity of wiring.

- h. Verify proper wire tagging at ends of conductors and cables.
  - i. Check conductors for insulation damage. Perform additional insulation resistance test of damaged conductors.
2. Operational and functional testing:
- a. Perform after completion of wiring checkout of equipment being tested.
  - b. If required, adjust and calibrate protective devices in accordance with specifications, and manufacturer's instructions and recommendations.
  - c. Check electrical systems and controls for proper sequence of operation, correct adjustments and settings, and agreement with schematic diagram.

**END OF SECTION**

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**SECTION 26 12 19**  
**PAD MOUNTED TRANSFORMER**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Pad Mounted Transformer:

1. Payment: Lump sum price offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI C12.20-2010 Electricity Meters 0.2 and 0.5 Accuracy Classes

B. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C2-2012 National Electric Safety Code
2. IEEE C57.12.00-2010 Liquid-Immersed Distribution, Power, and Regulating Transformers
3. IEEE C57.12.28-2014 Pad-Mounted Equipment Enclosure Integrity
4. IEEE C57.12.90-2010 Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

C. National Electrical Manufacturers Association (NEMA)

1. NEMA TR1-1993 (2000) Transformers, Regulators, and Reactors

D. National Fire Protection Association (NFPA)

1. NFPA 70-2014 National Electrical Code (NEC)

**1.03 QUALITY ASSURANCE**

A. UL Listed.

**1.04 DELIVERY, STORAGE, AND HANDLING**

A. Handle and store equipment in accordance with manufacturer's instructions:

1. Include copy of these instructions with equipment at time of shipment.

## **1.05 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 12 19-1, Approval Drawings and Data:
  - 1. Manufacturer's technical data.
  - 2. Equipment layout diagram.
  - 3. Nameplate list.
  - 4. Bill of materials.
  - 5. Schematic diagram.
  - 6. Wiring diagrams.
- C. RSN 26 12 19-2, Factory Test Report.
- D. RSN 26 12 19-3, Field Test Report.
- E. RSN 26 12 19-4, Final Drawings.
- F. RSN 26 12 19-5, Operation and Maintenance Instruction Book:
  - 1. Provide for all equipment.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Three-phase pad-mounted compartmental type transformer manufactured by Cooper Power Systems; or equal having essential characteristics shown below.

### **2.02 TRANSFORMER**

- A. Conform to IEEE C57.12.00, C57.12.28, and NEMA TR-1.
- B. Suitable for installation outdoors and operation under project conditions.
- C. Type: Self-cooled, outdoor, liquid-filled, three-phase, pad mounted.
- D. Dielectric coolant:
  - 1. Ester-based (soy).
  - 2. Listed less-flammable fluid meeting requirements of National Electrical Code and requirements of National Electrical Safety Code (IEEE C2).
  - 3. Non-toxic, non-bioaccumulating and be readily and completely biodegradable per EPA OPPTS 835.3100.

- E. Ratings and Features:
1. Capacity: 500-kVA.
  2. Primary Specifications
    - a. 4,160 volts, 3-phase, 60-hertz.
    - b. 60-kilovolts BIL
    - c. Delta without neutral bushing.
    - d. Taps: Two 2 1/2 percent FCAN and two 2 1/2 percent FCBN.
  3. Secondary Specifications:
    - a. 480Y/277 volts.
    - b. Grounded Wye with neutral fully insulated with removable ground strap.
    - c. 30-kilovolts BIL.
  4. Impedance in accordance with IEEE C57.12.00.

## **2.03 CONSTRUCTION**

- A. Construction:
1. Enclosure: Totally enclosed, dead front, with three-point latching security door with padlock.
    - a. In accordance with IEEE C57.12.28
    - b. Separate low-voltage compartment.
  2. Core: Grain oriented silicon steel.
  3. Windings: Copper.
  4. Four lifting lugs.
  5. Minimum two stainless steel NEMA 2-hole ground pads.
  6. Primary well.
  7. Secondary voltage bushings with 2-hole pattern NEMA spades.
  8. Sealed tank construction of sufficient strength to withstand a pressure of 7 pounds per square inch gauge (psig) without permanent distortion, and 15 psig without rupturing.
  9. Conduit and cable entry from full length bottom of termination chambers.

## **2.04 ACCESSORIES**

- A. Indicating and Protective Devices:
1. Located outside cable connection compartment.
  2. Provide NEMA 4 enclosure.

3. Instruments to include:
  - a. Liquid level gauge.
  - b. Dial type thermometer.
  - c. Automatic pressure relief device.
  - d. Pressure/Vacuum gauge.
- B. One-inch drain valve with sampling device and 1-inch upper fill plug.
- C. Nameplates:
  1. Manufacturer's nameplate:
    - a. Stainless steel laser engraved.
    - b. Nameplate shall meet IEEE C57.12.00 for Nameplate B.
  2. Engraved nameplates:
    - a. Material and size as shown on standard drawing 40-D-6234.
    - b. Provide equipment designation nameplate.
    - c. Provide nameplates for devices mounted on outside of doors that are not furnished with a manufacturer's nameplate or escutcheon.
    - d. Provide nameplate for devices mounted within low-voltage compartments.
- D. 480-Volt Bolted Connectors:
  1. Double lug, double bolted connections.
  2. Suitable for connecting at least two parallel sets of conductors.
- E. Pad: As provided by manufacturer.

## **2.05 FINISHES**

- A. Manufacturer's standard finish.

## **2.06 SOURCE QUALITY CONTROL**

- A. Transformer Factory Tests:
  1. Manufacturer's standard factory tests which shall include as a minimum:
    - a. Percent impedance (85 degrees C) at rated current and tap extremes.
    - b. Excitation Current (100 percent voltage) test.
    - c. Winding Resistance measurement tests.
    - d. Ratio Tests using all tap settings.
    - e. Polarity and Phase relation tests.
    - f. Applied and Induced potential tests.
  2. Testing conducted in accordance with IEEE C57.12.90.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Locate as shown on drawings.
- B. Install transformer on a galvanized steel channel base:
  - 1. Make channel base continuous around perimeter of equipment in accordance with drawings.
  - 2. Provide channel base with holes for grout and anchors in accordance with drawings.
  - 3. Set and level channel base on floor. Use of shims to level channel base is not acceptable.
  - 4. Bolt and grout channel base in place in accordance with Section 03 63 00 – Epoxy Grout.
  - 5. Furnish anchoring, supporting, and mounting materials required to install equipment.
- C. Make pad mounted transformer ready for energizing.
- D. Make all ground connections to ground system.

### **3.02 FIELD QUALITY CONTROL**

- A. Transformer Site Tests:
  - 1. Power factor.
  - 2. Excitation current.
  - 3. Turns Ratio.
  - 4. Insulation Resistance.
- B. Adjusting:
  - 1. Measure primary and secondary voltages and make appropriate tap adjustments.

**END OF SECTION**

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**SECTION 26 17 20**  
**METAL-CLAD SWITCHGEAR ASSEMBLY**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Metal-Clad Switchgear Assembly:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI C37.46-2010 High Voltage (>1,000V) Expulsion and Current-Limiting Power Class Fuses and Fuse Disconnecting Switches

B. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE 693-2005 Recommended Practice for Seismic Design of Substations
2. IEEE C2-2017 National Electric Safety Code
3. IEEE C37.04-2009 Rating Structure for AC High Voltage Circuit Breakers
4. IEEE C37.06-2009 AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities
5. IEEE C37.09-1999 Test Procedure for AC High Voltage Circuit Breakers
6. IEEE C37.20.2-2015 Metal-Clad Switchgear
7. IEEE C57.13-2016 Instrument Transformers
8. IEEE C62.11-2012 Metal-Oxide Surge Arresters for Alternating Current Power Circuits

C. National Equipment Manufacturers Association (NEMA)

1. NEMA FU 1-2012 Low Voltage Cartridge Fuses
2. NEMA LA 1-2009 Surge Arresters
3. NEMA SG 4-2009 Alternating-Current High-Voltage Circuit Breakers

- D. InterNational Electrical Testing Association, Inc. (NETA)
1. NETA ATS-2017 Acceptance Testing Specifications for Electrical Equipment and Systems
  2. National Fire Protection Association (NFPA)
  3. NFPA 70-2017 National Electrical Code (NEC)

### 1.03 PROJECT CONDITIONS

- A. Completely assembled and installed switchgear assembly shall operate as specified without derating under following conditions:
1. Pumping Plant No. 4:
    - a. Elevation 5,900-feet.
  2. Pumping Plant No. 7:
    - a. Elevation 6,300-feet.
  3. Temperature range: -35 degrees C to +40 degrees C.
  4. Seismic qualifications: Low Qualification level in accordance with IEEE 693.
  5. Wind loading: Withstand wind up to 90 miles/hour.
  6. Seismic and wind forces do not occur simultaneously.

### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals and Section 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 17 20-1, Approval Drawings and Data:
1. Manufacturer's technical catalog data marked with corresponding Bill of Materials (BOM) item number.
  2. Layout drawings.
    - a. Switchgear arrangement.
    - b. Channel base.
  3. Equipment data:
    - a. Total weight of switchgear assembly and additional impact load during opening operation of breaker.
    - b. Weight of removable element of circuit breaker.
    - c. Circuit breaker tripping and closing currents.
    - d. Description of bus bar insulation system.
  4. Equipment Nameplate list.
  5. Device Nameplate list.

6. BOM.
  7. Time-Current Characteristic Fuse Curves.
- C. RSN 26 17 20-2, Approval Drawings:
1. Schematic Diagrams.
  2. Wiring Diagrams.
- D. RSN 26 17 20-3, Check Prints.
- E. RSN 26 17 20-4, Factory Test Reports:
1. For design tests, certificates stating equipment has passed all applicable referenced design tests are acceptable in lieu of submitting actual test reports.
- F. RSN 26 17 20-5, Field Test Reports.
- G. RSN 26 17 20-6, Final Drawings.
- H. RSN 26 17 20-7, Operation and Maintenance Instruction Book.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. In accordance with IEEE C37.20.2

## **1.06 EXTRA MATERIALS**

- A. Furnish special tools and accessories required for installation, normal operation, and maintenance.
- B. Furnish Spare Parts:
1. Identical to and interchangeable with equipment being furnished with switchgear assembly.
  2. Circuit breaker moving contact and stationary contact assembly, complete for one pole. Vacuum bottle assembly complete for one pole.
  3. One spare blank terminal block marking strip for each terminal block furnished.
  4. One fuse of each type and size used.
  5. One indicating light assembly of each color, size, type used.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Complete metal-clad switchgear lineup fabricated by same manufacturer as motor control equipment and low voltage switchboards. Distributor or packager modifications to third-party standard product is not acceptable.

- B. VacClad-W metal-clad switchgear with type VCP-W vacuum circuit breakers manufactured by Eaton; or equal having essential characteristics shown below.

## 2.02 SWITCHGEAR ASSEMBLY

- A. Conform to IEEE C37.20.2.
- B. Type: Outdoor, dead front, with energized parts behind grounded metal barriers.
- C. Ratings:
  - 1. Maximum voltage: 15-kV, rms.
  - 2. Lightning impulse withstand: 95-kV, peak.
  - 3. Continuous current: 1,200 A, main bus.
  - 4. Momentary current: Not less than close-and-latch capability of circuit breaker.
  - 5. Short-time current: Not less than short-time withstand rating of circuit breaker.
  - 6. Frequency: 60-hertz.
- D. Construction Features:
  - 1. Shield energized low-voltage terminals exposed by door opening with removable cover.
  - 2. Equip high-voltage drawer or trunnion-mounted devices with automatic grounding devices.
  - 3. Determine number of switchgear sections from drawings, including required bus transition sections.
  - 4. High-voltage cable entries: Conduits from below.
  - 5. Low-voltage control and auxiliary power cable entry into switchgear assemblies: Conduits from below.
- E. Bus: Copper.
- F. Enclosures:
  - 1. Outdoor, weatherproof, IEEE C37.20.2: Category A.
  - 2. "Non-walk-in" type which provides front of each section with at least one inside door, or equivalent, and one outside weatherproof door.
  - 3. Inside doors to provide access to equipment cavity and may be used for mounting control and metering devices.
  - 4. Outside weatherproof doors:
    - a. Provide access and protection to front of section.
    - b. Do not mount electrical devices on outside door.

- c. Equip with top and bottom strikes, and center latch. Strikes and latch shall pull door securely against gasket and enclosure. Mechanism used to pull door against gasket and enclosure shall be adjustable.
- d. Door handle shall engage latch and strikes.
- e. Door handles shall be pad lockable.
- 5. Slope top of outdoor equipment away from front of enclosures.
- 6. Seal weatherproof doors and outdoor enclosure walls with neoprene gaskets.
- 7. Equip ventilation openings with filters.

### **2.03 CIRCUIT BREAKERS**

- A. Conform to IEEE C37.04, C37.06, and NEMA SG4.
- B. Type:
  - 1. Vacuum with motor-compressed spring stored-energy mechanism.
  - 2. Three-pole, single-throw, back-connected, latch-in, removable-element type.
  - 3. Trip Free in all positions.
- C. Ratings:
  - 1. Nominal System Voltage: 4.16-kV, rms.
  - 2. Maximum voltage (minimum): 4.76-kV, rms.
  - 3. Full Wave Withstand (BIL): 60-kV, peak.
  - 4. Continuous Current: 1,200 A, rms.
  - 5. Short-Circuit/Short Time Current (minimum): 10,000 A, rms.
  - 6. Interrupting Time - Cycles: 5 cycles.
  - 7. Closing and Latching Capability (minimum): 26,000 A, crest.
- D. Construction Features and Accessories:
  - 1. Locate manual closer and opener on front panel of removable element.
  - 2. Closing Speed of Contacts: Independent of control voltage and operator.
  - 3. Visual indications:
    - a. On front of breaker panel.
    - b. Circuit breaker contact position.
    - c. Spring charge condition.
    - d. Operation counter.
  - 4. Mechanical interlocks to prevent insertion or removal of circuit breaker removable elements while circuit breaker is in closed position.

5. Mechanical interlocks to prevent circuit breaker from closing unless primary disconnecting devices are in fully closed contact.
6. Internal wiring shall be NEC Type SIS, size 14 AWG min., and terminators shall be insulated ring-tongue type utilizing lock washers.
7. Self-coupling, separable, adjustable ground plate.
8. Mechanism Operated Contact (MOC) switch interface shall completely close and latch breaker contacts without stalling and with no harm to MOC switch.

E. Control and Operational Features:

1. Closing and tripping power: 120 Vac.
2. Stored energy mechanism motor operator power: 120 Vac.
3. Capacitive trip device.
4. Breaker closing will normally be by operator pendant-connected control switch operation.
5. Manual close and trip for emergency operation, test, and withdrawn positions.
6. During closing operation, stored energy springs shall be automatically charged for tripping.
7. Provide manual charging of stored energy mechanism for use during power outages or testing.
8. Auxiliary switches with not less than 5 spare "a" contacts and 5 spare "b" contacts.
9. Local operation of circuit breaker from control circuit while breaker is in test position.
10. Initiate breaker tripping by operator control switch or protective relays.
11. Latch breaker closed so loss of station power or control power does not cause breaker tripping.
12. Removal of breaker element shall automatically trip breaker and release springs.
13. In installed breaker position, stored-energy mechanism shall automatically charge following a trip operation.

## **2.04 CURRENT TRANSFORMERS**

- A. Conform to IEEE C57.13, C37.04, and NEMA SG4.
- B. Bushing or window type.
- C. Multi-ratio. Ratios as indicated on drawings.
- D. Accuracy Class: As indicated on drawings.

## 2.05 SURGE ARRESTERS

- A. Conform to IEEE C62.11 and NEMA LA 1.
- B. Type: Metal-oxide.
- C. Construction: Polymer housing.
- D. Station class.
- E. Protective characteristics as specified in Table 26 17 20A - Surge Arrester Protective Characteristics.

Table 26 17 20A - Surge Arrester Protective Characteristics

TOV, 1 sec.	MCOV, kV rms; not less than:	Maximum Equivalent Front-of – Wave, kV crest	Maximum Discharge Voltage, kV crest Using 8/20 Current Wave @			Maximum Switching Surge, kV crest
			5kA	20kA	40kA	
5.2 kV	4.4 kV	23.9 kV	TBD	TBD	TBD	13.5 kV

## 2.06 POTENTIAL TRANSFORMERS

- A. In accordance with IEEE C57.13, C37.04, and NEMA SG4.
- B. Ratings and Connection: As shown on drawings.
- C. Drawout type.
- D. Fuse:
  1. In accordance with ANSI C37.46.
  2. Current-limiting type.
  3. Sized by PT manufacturer.
  4. Interrupting rating: TBD (rms, symmetrical).

## 2.07 PROTECTIVE RELAYS

- A. Provide on each feeder and utility source.
- B. SEL-751A Relay as manufactured by Schweitzer Engineering Laboratories, Pullman, Washington; or equal, having the following essential characteristics:
  1. Multifunction, digital relay that monitors 3-phase, alternating-current and voltage.
  2. Output relays: Trip relay, alarm relay. Output relays to be programmable.

3. Self-diagnostics failure function: Continually monitor its own functions and trip or alarm in case of failure.
4. Protective functions:
  - a. Phase instantaneous overcurrent (50).
  - b. Phase inverse time overcurrent (51).
  - c. Under/Overvoltage Protection (27/59).
  - d. 120-VAC Control Input.
  - e. 5-ampere current Input.
  - f. 120-VAC Voltage Input.
  - g. Programmable for Arc Flash Maintenance Mode Switch use.
5. Integrated Modbus RTU communications.

## **2.08 ACCESSORY DEVICES**

- A. Compatible with associated electrical, mechanical, and thermal ratings of circuit breakers.
- B. Provide device to permit removing and handling breaker element by one person.
- C. UL listed, where applicable.
- D. Suitable length of control cable, with plug and receptacle, to permit test of removable breaker element while in withdrawn position, from control circuit.
- E. Control Switches:
  1. Pistol-grip handle switches:
    - a. 600-volts alternating current or direct current.
    - b. 20-amperes continuous current.
  2. Contacts: Silver plated and of self-wiping action type.
- F. Arc Flash Maintenance Mode Selector Switch circuit for each feeder breaker overcurrent circuit:
  1. Include blue LED lamp for maintenance mode enabled.
- G. Hand Held Pendant Pushbutton Station:
  1. OPEN and CLOSE pushbuttons.
  2. Minimum 25-foot umbilical cord.
- H. Remote Racking Device:
  1. Allows for open/close operation and in/out racking at a safe distance.

2. Torque switch mechanism to stop racking motor.
3. Powered by plug connection to 120 Vac receptacle.
4. Hand held pendant racking control station:
  - a. Minimum 25-foot umbilical cord
  - b. Open, Close, In, and Out pushbuttons. Enable pushbutton for two-hand operation.
  - c. Permissive circuit provisions.

I. Engraved Nameplates and Warning Signs:

1. Signs, size, engraving, and material: As indicated on standard drawing 40-D-6234.
2. Provide nameplates and warning signs for following:
  - a. Overall switchgear assembly: Manufacturer's nameplate:
    - 1) Place manufacturer's name, trademark, or other descriptive marking on all electrical equipment.
    - 2) Provide other markings: Voltage, current, wattage, or other ratings as specified.
  - b. Each section of switchgear assembly: Designations as indicated on drawings or as follows:
    - 1) Mount nameplates for each device on a door.
    - 2) Nameplates for each device mounted within switchgear enclosure. In lieu of furnishing nameplates, Contractor may fulfill this requirement by identifying each device with device name or standard NEMA designation by typed or computer-generated permanent marking on or adjacent to device.
    - 3) High-voltage compartment. Warning sign mounted on access door or barrier to each high-voltage compartment. Sign shall carry notation "DANGER - High-voltage compartment."
3. No hand lettering.

J. Enclosure Wire:

1. NEC type SIS wire.
2. No. 14 AWG copper conductor minimum with the current transformer wiring No. 10 AWG minimum.
3. Class K stranded.
4. 600-volts.

- K. Fuses and Fuse-holders:
1. Voltage rating: 600-volts.
  2. UL listed.
  3. Fuses:
    - a. In accordance with NEMA FU1.
    - b. Current-limiting type.
    - c. Current ratings determined by Contractor.
    - d. Suitable for 'finger-safe' type fuse holders.
  4. Fuse-holders:
    - a. Modular 'finger-safe' type.
    - b. Current rating: Not less than fuse size.
    - c. Furnish with nameplate identifying protected circuit.
    - d. Mount in easily accessible location within control cabinet.
- L. Space Heaters:
1. Provide as necessary to prevent condensation.
  2. Suitable for 120-VAC service.
  3. Thermostatically controlled and be adjustable.
  4. Provide with protective covers.
- M. Terminal Blocks:
1. Rated 600-volts, 30-amperes.
  2. Molded-block type to accommodate ring lugs one half of an inch wide (outer diameter) at terminal screws.
  3. Furnish with binding-head or washer-head screws having serrated or grooved contact surfaces or lockwashers.
  4. Molded insulating barriers between terminals.
  5. Shorting-type for current transformer wiring.
  6. Removable covers and marking strips.
  7. Provide 20 percent spare terminals on each terminal block for connections to external circuits.
  8. Provide marking strips with conductor designations typed or computer generated. No hand lettering.
- N. Terminal Connectors:
1. Pressure-crimp-type ring connectors:
    - a. Tin-plated copper serrated inner barrel.

2. Pressure-crimp-type pin connectors:
  - a. Tin-platted copper.
  - b. For use only on device terminals not suitable for ring connectors.
3. Insulation: 600-volts, nylon or vinyl.

O. Wire Markers:

1. Type: Self-laminating-vinyl or heat-shrink.
2. Color: White.
3. Lettering: Machine. Do not print wire markers by hand.

## 2.09 FABRICATION

A. General:

1. Completely wire switchgear. Tag cables going between switchgear sections.
2. Twist hinge wiring around axis of wire instead of bending laterally.
3. Firmly clamp wiring on hinged panels near hinged side of panels and terminate on adjacent blocks on stationary part of switchgear.
4. Equip switchgear with wiring to terminal blocks for connection to control and relaying circuits.
5. Coordinate location of openings for conduits from below.
6. Mount relays so vibration caused by door closing or breaker operation will not cause false operation.

B. Protective Relays:

1. Panel-mount on the internal door of the applicable switchgear section.
2. Wire to instrument transformers through relay test switches.

C. Ground Bus:

1. Install ground bus in accordance with IEEE C37.20.2. Electrically bond to enclosure.
2. Ground bus shall be accessible from front of cubicle.
3. Provide lugs or terminals on ground bus suitable for connection to ground system with 4 AWG bare copper conductors.

D. Terminal Blocks:

1. Arrange terminal blocks to allow external cabling to be supported and to allow easy connection of incoming and outgoing cables.

2. Mount terminal blocks at least 3-inches from panel edges and other devices. Mount adjacent rows of terminal blocks with 6-inches separation minimum. Access to front of terminal blocks shall be unobstructed.
  3. Provide 1 spare 12-terminal block per breaker section.
  4. Machine letter designations on terminal block marking strips. Do not use hand lettering.
  5. Identify vertical columns of terminal blocks with a single letter such as “A”, “B”, “C”. Vertical columns may contain more than 12 termination points.
  6. Terminate current transformer secondary wiring on short-circuiting type terminal blocks.
- E. Wiring and Wiring Connections:
1. Make all connections at device terminals or terminal blocks. Maximum two wires at terminations. Wire splices are not acceptable.
  2. Support and secure wire bundles with cable tie mounting bases. Secure cable tie mounting base with two No. 8 screws. Mounting cable tie bases with only adhesive will not be allowed.
  3. Install ring tongue pressure-crimp-type connectors for terminations at terminal blocks and electrical devices.
  4. Do not terminate wire without terminal connector.
- F. Wire Markers:
1. Install wire markers on conductor end.
  2. Print conductor designation on first line.
  3. Print conductor destination and terminal number on second line.
- G. Nameplates:
1. Attach nameplates with pan head self-tapping screws. Do not use adhesives to attach nameplates.

## **2.10 FINISH**

- A. Switchgear Assembly: In accordance with IEEE C37.20.2 and utilizing manufacturer’s standard methods and materials for complying with IEEE, except as follows:
1. Interior: Manufacturer’s standard ‘White’ finish.
  2. Materials for paint system: Must be certified ‘lead- and chromate-free’, including painting systems and equipment.
- B. Metal-clad Circuit Breaker: Manufacturer's standard finish.

## **2.11 CONTRACTOR SOURCE QUALITY TESTING**

- A. Inspection and Witnessing:
  - 1. Government may, at its option inspect equipment and witness factory tests.
  - 2. Notify COR, in writing, at least 14-days in advance of factory testing.
- B. Circuit Breaker:
  - 1. Factory Tests:
    - a. Design tests in accordance with IEEE C37.09 on circuit breaker of same type, style, and model furnished.
    - b. Production tests in accordance with IEEE C37.09.
- C. Switchgear Lineup(s):
  - 1. Factory Tests:
    - a. Production tests in accordance with IEEE C37.20.2.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. In accordance with applicable requirements of IEEE C37.20.2, IEEE C2, NFPA 70, and these specifications.
- B. As indicated on drawings.
- C. Install Switchgear on Galvanized Steel Channel Base:
  - 1. Make channel base continuous around perimeter of equipment in accordance with drawings.
  - 2. Provide channel base with holes for grout and anchors in accordance with drawings.
  - 3. Set and level channel base on floor. Do not use shims to level channel base.
  - 4. Bolt and grout channel base in place in accordance with Section 03 63 00 – Epoxy Grout.
  - 5. Bolt motor control equipment in place on channel base after grout has cured.
  - 6. Furnish anchoring, supporting, and mounting materials required to install equipment.
- D. Ground and bond switchgear to building ground system in accordance with Section 26 05 20 - Grounding and Bonding.

**3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Wiring checkout in accordance with Section 26 05 90 – Wiring Checkout and Tests.
- B. Field acceptance testing in accordance with NETA ATA and IEEE C37.20.2.

**END OF SECTION**

**SECTION 26 18 39**  
**MEDIUM-VOLTAGE MOTOR CONTROLLERS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Medium-Voltage Motor Controllers:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. Institute of Electrical and Electronics Engineers (IEEE)

- |    |                    |  |
|----|--------------------|--|
| 1. | IEEE 18-2012       | Shunt Power Capacitors   |
| 2. | IEEE 1036-2010     | Guide for Application of Shunt Power Capacitors                                |
| 3. | IEEE C37.20.7-2007 | Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults |
| 4. | IEEE C57.13-2016   | Standard Requirements for Instrument Transformers                              |

B. National Electrical Manufacturers Association (NEMA)

- |    |                       |   |
|----|-----------------------|---|
| 1. | NEMA CP 1-2000(2008)  | Shunt Capacitors  |
| 2. | NEMA ICS 1-2015       | Industrial Control and Systems General Requirements   |
| 3. | NEMA ICS 3-2005(2010) | Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC  |
| 4. | NEMA ICS 3.1-2009     | Industrial Control and Systems: Guide for the Application, Handling, Storage, Installation and Maintenance of Medium Voltage AC Contactors, Controllers and Control Centers |
| 5. | NEMA ICS 5-2017       | Industrial Control and Systems Control Circuit and Pilot Devices  |
| 6. | NEMA ICS 6-2006       | Industrial Control and Systems Enclosures   |

C. National Fire Protection Association, Inc. (NFPA)

- |    |              |                                |
|----|--------------|--------------------------------|
| 1. | NFPA 70-2017 | National Electrical Code (NEC) |
|----|--------------|--------------------------------|

### 1.03 SYSTEM DESCRIPTION

- A. One assembly of medium voltage reduced-voltage (soft) starters (motor controllers), isolation contactors, bypass contactors, power factor correction capacitors, and capacitor contactors, and power factor correction capacitor control system.
- B. Design Requirements:
  - 1. Design layout of medium-voltage motor controller sections.
  - 2. Design medium-voltage motor controller sections and power factor correction capacitor sections to be grouped together in a continuous line-up and to be connected with a common horizontal bus.
  - 3. Determine size and ratings of the following:
    - a. Medium-voltage and low-voltage fuses.
    - b. Control circuit transformers.
    - c. Instrument transformers.
    - d. Space heaters.
    - e. Power factor correction capacitors:
      - 1) Size of power factor correction capacitors must be coordinated with Max kVAR rating of associated pump motor. Exceeding this rating could result in equipment damage.
  - 4. Determine current transformer ratios.
  - 5. Design controls for automatic soft starting with application of bypass contactor and power factor correction capacitors upon reaching full speed operation.
  - 6. Design controls using Modbus RTU communication as the primary interface between motor starter and pumping plant control PLC.
  - 7. Design protection circuits to open isolation contactor on protective action.
  - 8. Designed, manufactured, assembled, and tested in accordance with IEEE, NEMA, ICS, and NEC standards.
  - 9. Design control system for switching power factor correction capacitors. Control system to have following features:
    - a. Control logic may be hard wired relays or soft logic with PLC or similar device.
    - b. Capacitors to be switched with separate capacitor vacuum contactor.
    - c. All capacitors within lineup to be switched OFF while solid-state starter ramps.
    - d. After completion of ramp cycle, capacitors for energized starters are sequenced back ON one at a time.

- e. Provide separate control power transformer for control system. Determine kVA rating.
- f. A maximum of two capacitors and its contactor may be stacked within single enclosure.

#### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals and Section 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 18 39-1, Approval Data:
  - 1. Manufacturers' technical data.
- C. RSN 26 18 39-2, Approval Drawings:
  - 1. Layout Drawings.
    - a. Motor control equipment arrangement.
    - b. Channel base.
  - 2. Nameplate list.
  - 3. Bill of materials.
- D. RSN 26 18 39-3, Approval Drawings:
  - 1. Schematic diagrams:
    - a. Include a separate schematic diagram drawing for each motor control circuit.
  - 2. Wiring diagrams:
    - a. Include separate wiring diagram for each motor control cubicle.
- E. RSN 26 18 39-4, Check Prints:
  - 1. Schematic diagrams.
  - 2. Wiring diagrams.
- F. RSN 26 18 39-5, Factory Test Report.
- G. RSN 26 18 39-6, Field Test Report.
- H. RSN 26 18 39-7, Final Drawings:
  - 1. Layout drawings.
  - 2. Schematic diagrams.
  - 3. Wiring diagrams.

- I. RSN 26 18 39-8, Operation and Maintenance Instruction Book:
  - 1. Include the following:
    - a. Title page/index.
    - b. Manufacturer's maintenance and operating instructions.
    - c. Bill of materials.
    - d. Copies of informational data.
    - e. Half-size prints of Final drawings.
    - f. Time-current characteristic curves.
    - g. Motor overload relay settings.

### **1.05 REGULATORY REQUIREMENTS**

- A. UL listed and labeled.

### **1.06 DELEVERY, STORAGE, AND HANDLING**

- A. Handle and store equipment in accordance with manufacturer's instructions and recommendations and in a manner to avoid damage to internal components, metal enclosure, and finish. Include copy of these instructions with equipment at time of shipment.
- B. Store indoors in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect equipment from dirt, water, and construction debris.

### **1.07 EXTRA MATERIALS**

- A. Furnish the following spare parts:
  - 1. Three vacuum bottles for each size of contactor furnished.
  - 2. One main operating coil for each size of contactor furnished.
  - 3. Six medium-voltage power fuses for each different size furnished.
  - 4. Six low-voltage fuses of each type and size furnished.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Complete medium-voltage solid-state reduced voltage start system with power factor correction equipment fabricated by same manufacturer as metal-clad switchgear and low voltage switchboards. Distributor or packager modifications to a third-party standard product is not acceptable.

- B. AMPGARD medium-voltage solid-state reduced voltage starter manufactured by Eaton; or equal having essential characteristics as stated below.

## **2.02 RATINGS AND GENERAL REQUIREMENTS**

- A. Controller Type: Non-reversing, solid-state reduced voltage starter for induction motor.
- B. System Voltage: 4.16 kV, three-phase 3-wire, solidly grounded, 60-hertz.
- C. Main Bus Ampacity: 1,000-amperes, continuous.
- D. Medium Voltage Controllers: Integrated interrupting rating of 200 MVA with current limiting fuses.
- E. Maximum Short-Circuit Current: 30 kA RMS symmetrical.

## **2.03 ENCLOSURE**

- A. Constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts.
- B. Provide a degree of protection against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and filings).
- C. Provide a degree of protection to the ingress of water (dripping and light splashing).
- D. Material: Manufacturer's standard gauge sheet steel.
- E. Enclosures completely front accessible, allowing for freestanding, against wall, or back-to-back mounting.
- F. Vertical Sections:
  - 1. Provide metal barrier between low-voltage and high-voltage compartments.
  - 2. Provide each compartment with a separate door.
  - 3. Do not combine controllers for more than one motor in each section.
- G. Provide separate metering section if required.
- H. Incoming power is by cable. Provide sufficient space to accommodate number and size of incoming cables for bottom entry.

## **2.04 BUSES AND BUS CONNECTION**

- A. Horizontal and Vertical Buses:
  - 1. Copper tin-plated, solid bar type.
  - 2. Insulated to withstand system voltage.

3. Horizontal bus length: Length of motor starter cubicle.
4. Braced to withstand, without damage or deformation, maximum short-circuit current.

B. Ground Bus:

1. Copper bar.
2. Extend length of each motor starter section cubicle and each unit control section.

## **2.05 MOTOR CONTACTOR AND POWER FUSES**

A. Motor Contactor and Fuses: Integral bolt-in assembly.

B. Motor Contactor:

1. Type: Class E2 motor controller, vacuum, 3-pole, 400 amperes.
2. Rated voltage: 7,200-volts.
3. Single-break high pressure type main contacts with weld-resistant alloy contact faces.
4. Operating coil:
  - a. Suitable for operation from 120-volt, 60-hertz.
  - b. Full voltage energize and hold.
  - c. Equip direct-current coil with integral rectifier.
  - d. Provide transient protection if required by manufacturer.
5. Auxiliary switches with contacts to perform functions shown.
6. Provide built-in test circuit to permit checking starter control and pilot circuits, with high-voltage de-energized and isolated, and with contactor in its normal position or in draw-out position. Control circuit to be capable of being energized through polarized plug connector from external 120-volt, 60-hertz source.
7. Coordinate and interlock with soft starter to bypass reduced-voltage starting components after motor full speed is achieved.

C. Load-Break Main Disconnect Switch:

1. Externally operated, two position, manual three-pole device.
2. Mechanical interlocks:
  - a. Prevent opening of high-voltage access door with disconnect switch closed.
  - b. Be directly attached to operating mechanism without relying on cables or long linkages.
3. Provide grounding clips for positive grounding of starter and main fuses when isolating switch is open.

4. Provide viewing port to enable visible verification of blade position.
5. Provide switch-operating handle with provisions for padlocking.
6. Provide remote operator for isolation switch to allow opening and closing switch from outside arc flash boundary.

D. Power Fuses:

1. Type: Medium-voltage, current-limiting, R-rated with blown fuse indicator.
2. Incorporate time-current characteristics for motor service allowing proper coordination with contactor and overload relay for maximum protection.
3. Fuse holder designed to permit easy inspection and replacement of fuses without starter disassembly.
4. UL recognized.

E. Bypass and Power Factor Capacitor Contactor:

1. Type: Vacuum, 3-pole, 400-amperes.
2. Rated voltage: 7,200-volts.
3. Operating coil:
  - a. Suitable for operation from 120-volt, 60-hertz.
  - b. Full voltage, energize and hold.
  - c. Equip direct-current coil with integral rectifier.
  - d. Provide transient protection if required by manufacturer.

## 2.06 MOTOR PROTECTION RELAY (MPR)

A. SEL-749M Motor Relay and SEL-2600 RTD Module as manufactured by Schweitzer Engineering Laboratories, Pullman, Washington; or equal, having the following essential characteristics:

1. Multifunction, digital relay that monitors 3-phase, alternating-current and makes separate trip and alarm decisions based on preprogrammed motor current and temperature conditions.
2. Control power input: 90- to 260-volts, 60-hertz.
3. Output relays: Trip relay, alarm relay, and two auxiliary output relays. Output relays to be programmable.
4. Self-diagnostics failure function: Continually monitor its own functions and trip or alarm in case of failure.
5. Protective functions:
  - a. Undervoltage (device 27).
  - b. Overvoltage (device 59).

- c. Phase overload standard curves (device 51).
  - d. Phase overload custom programmable curve (device 51).
  - e. It modeling (device 49).
  - f. Stator over temperature/bearing over temperature with 10 independent RTD inputs (device 49).
  - g. Negative sequence unbalance/single-phase (device 46).
  - h. Phase reversal (device 47).
  - i. Starts per hour and time between starts (device 48).
  - j. Short circuit (device 50).
  - k. Ground fault (devices 50G/50N/51G/51N).
  - l. Undercurrent (device 37).
  - m. Mechanical jam/stall.
6. Management functions:
- a. Statistical data.
  - b. Pre-trip-data.
  - c. Ability to learn, display and integrate critical parameters to maximize motor protection.
  - d. Communication with external devices using a RS485 port and Modbus RTU protocol.
  - e. Keypad and LCD display.

## **2.07 COMPONENTS**

- A. Control Power Transformer (CPT):
- 1. Encapsulated, dry-type with copper windings.
  - 2. Voltage: 4,160-120-volts, 60-hertz.
  - 3. Provide with primary and secondary fuse blocks and current limiting fuses.
- B. Selector Switches:
- 1. Type: Heavy-duty, oiltight with 30.5-mm mounting hole.
  - 2. Number of Positions: As shown.
  - 3. Contact rating: A600 in accordance with NEMA ICS 5.
  - 4. Black extended lever operator.
  - 5. Nameplate: Equipment manufacturer's standard or custom nameplate suitable for mounting directly over device. Engraving as shown.
- C. Pushbuttons:

1. Type: Momentary, heavy-duty, oiltight with flush head and 30.5-mm mounting hole.
  2. STOP Pushbutton: Two position, push-pull type with red mushroom head.
  3. Contact rating: A600 in accordance with NEMA ICS 5.
  4. Nameplate: Equipment manufacturer's standard or custom nameplate suitable for mounting directly over device. Engraving as shown.
- D. Indicating Light Assemblies:
1. Type: Heavy-duty, oiltight, push-to-test.
  2. Voltage: 120-volts, 60-hertz.
  3. Lamp: Full voltage, high-visibility LED with multiple LEDS install in lamp base. Single LED in lamp base is not acceptable.
  4. Color: As shown.
  5. Nameplate: Equipment manufacturer's standard or custom nameplate suitable for mounting directly over device. Engraving as shown.
- E. Auxiliary Relays:
1. Self-resetting, heavy-duty, machine-tool type with convertible contacts. Latching type relays are mechanically latched and electrically reset. General purpose type relays are not acceptable.
  2. Coil Voltage: 120-volts, 60-hertz.
  3. Contact rating: A600 in accordance with NEMA ICS 5.
- F. Timing Relays:
1. Bulletin 700 Type RTC solid-state timing relay as manufactured by Rockwell Automation; or equal, with following essential characteristics:
  2. Type: Solid-state, with adjustable timing range as shown.
  3. Voltage: 120-volts, 60-hertz.
  4. Operating mode: On-Delay.
  5. Contact configuration:
    - a. Two timed contacts, one Normally Open (NO) and one Normally Closed (NC).
    - b. Two instantaneous contacts one Normally Open (NO) and one Normally Closed (NC).
  6. Contact rating: B600 in accordance with NEMA ICS 5.
- G. Terminal Blocks:
1. Type: One piece, molded-block with molded-insulating barrier between terminals. Do not use sectional type of terminal blocks.

2. Rating: 600-volts, 25-amperes, minimum.
3. Terminals: Binding-head or washer-head screws with serrated or grooved contact surfaces suitable for use with ring-type terminal connectors.
4. Provide marking strips with conductor designations typed or computer generated.
5. Provide shorting type terminal blocks for current transformer circuits.

H. Terminals Connectors:

1. Heavy-duty, pressure-crimp type.
2. Connector: Tin-plated copper, serrated inner barrel.
3. Style: Ring or pin type.
4. Insulation: 600-volts, nylon or vinyl.
5. UL listed.
6. Compatible with conductor and terminal block used.

## **2.08 REDUCED VOLTAGE (SOFT) STARTER**

A. Sized for applications shown on drawings.

B. Operator Interface:

1. Provided with programmable keypad with backlit LCD display.
2. Provided with status and alarm LEDs.
3. Provided with non-volatile memory.
4. Display and monitor functions:
  - a. Motor current in each phase.
  - b. RTD temperature.
  - c. Most recent trip and alarm.

C. Soft Starter Module Programmable Functions:

1. Initial current.
2. Motor full-load current.
3. Dual ramp adjustments with two independent settings for the following:
  - a. Initial voltage: 0 to 100 percent of nominal voltage.
  - b. Current limit: 200 to 600 percent of motor full-load current.
  - c. Acceleration time: 1- to 120-seconds.
4. Deceleration time: 1- to 60-seconds.

- D. Communications: Modbus RTU via RS485/RS232 or RS422 with Windows interface:
1. Provide for remote start/stop and control interlocks.
  2. Provide for data acquisition of starter and pump equipment status as shown.

## **2.09 POWER AND ENERGY METER**

- A. Eaton IQ 150 electronic power meter as manufactured by Eaton; or equal, having the following essential characteristics:
1. Microprocessor based and designed for multifunction electrical measurement on 3-phase power system.
  2. User programmable for voltage range to any PT ratio. Accept a direct voltage input range of up to 416-volts line-to-neutral and 721-volts line-to-line.
  3. User programmable for current to any CT ratio and accept current input up to 11-amperes continuous.
  4. Provide true RMS measurements of phase-to-phase voltage and per phase current.
  5. Accuracy: Plus or minus 0.25 percent for volts, and 0.5 percent for power and energy functions.
  6. Provide Volts, Amps, VAR, VA, PF, Frequency, Watthours, VARh, and VAh.
  7. Provide meter with three-line LED display. Meter display to include a percent of FULL SCALE having not less than 10 segments.
  8. Be a traceable revenue meter, which contains utility grade test pulse allowing power providers to verify and confirm meter is performing to its rated accuracy.
  9. Provide meter with Modbus RTU communication format.
  10. Allow user to set up utility demand profile:
    - a. Readings for kW, kVAR, kVA, and PF calculated using utility demand features.
    - b. All other parameters have MAX and MIN capability over user selectable averaging period.
    - c. Provide voltage with instantaneous MAX and MIN reading displaying highest surge and lowest sag seen by meter.
  11. Meter capable of operating on a power supply of 90- to 265-volts, 60-hertz.
  12. Meter to be same manufacturer and type as that provided for the Switchboards as specified in Section 26 24 13 – Switchboards.
  13. UL listed.

## 2.10 INSTRUMENT TRANSFORMERS

- A. Potential Transformers (PT):
1. Designed for service in medium-voltage switchgear and for use in metering and relaying circuits.
  2. Designed to withstand Basic Impulse Level (BIL) of switchgear.
  3. Drawout type mounted on steel carriage and installed in separate drawout compartment.
  4. Provide for PT withdrawal from operating position via racking device with PT compartment door closed.
  5. Ensure fuses completely disconnected in withdrawn position and exposed parts are visibly grounded.
  6. Design to allow for replacing fuses and general maintenance.
  7. PT connection as shown.
- B. PT Fuses:
1. Current-limiting type.
  2. Provide in primary circuit.
  3. E-rated and 5.5 kV.
  4. UL listed.
- C. Current Transformers (CT):
1. Type: Indoor, window type with shorting terminal block.
  2. Five ampere secondary.
  3. Insulation: 600-volt, 10 kV BIL.
  4. Accuracy Class: Suitable for metering service shown.
  5. Polarity identified with standard marking symbols.
  6. Provide all required mounting devices.
- D. Instrument transformers conform to IEEE C57.13.

## 2.11 POWER FACTOR CORRECTION CAPACITORS

- A. Enclosure: Manufacturer's standard sheet steel suitable for mounting within cabinet of medium-voltage motor controller lineup.
- B. Voltage: 4,160, 3-phase, 60-hertz.
- C. Estimated rating (to be coordinated with associated pump motor Max kVAR rating):  
1,000 HP kVAR.

- D. Dielectric Fluid: Non-PCB, nonflammable, and biodegradable.
- E. Provide with fuses that have visual means of detecting blown fuse.
- F. Provide discharge resistor in capacitor to bring voltage down to 50-volts in less than 5-minutes after isolation of capacitor.
- G. Operate without shortened life with an average 24-hour ambient air temperature of 35 degrees C.
- H. Finish: Manufacturer's standard Grey coating.
- I. Conform to NEMA CP 1 and NFPA 70.

## **2.12 POWER FACTOR CORRECTION CAPACITOR CONTROL SYSTEM**

- A. Components: Suitable for application and manufacturer's standard.

## **2.13 ENCLOSURE WIRE**

- A. 14 or 16 AWG type SIS stranded copper with 600-volt insulation.
- B. Insulated conductors used to connect components external to medium-voltage motor controller lineup to be in accordance with Section 26 05 10 – Conductors and Cables.
- C. UL listed.

## **2.14 NAMEPLATES AND WARNING SIGNS**

- A. Manufacturer's Nameplates:
  - 1. Material and size: Manufacturer's standard durable, permanent nameplate.
  - 2. Nameplate engraving with manufacturer's name, trademark, or other descriptive marking and with voltage, current, or other ratings as required by standards.
- B. Engraved Nameplates:
  - 1. Material and size as shown on standard drawing 40-D-6234.
  - 2. Provide nameplate for each starter section engraved with equipment designation.
  - 3. Provide nameplate for each door, which describes purpose of compartment.
  - 4. Provide nameplate for devices mounted on outside of doors that are not furnished with manufacturer's nameplate or escutcheon.
  - 5. Provide nameplate for devices mounted within low-voltage compartments.
- C. Warning Signs:
  - 1. Provide warning sign for hinged access doors and accessible bolted plates of compartments where operating voltage exceeds 600-volts.

2. In accordance with Occupational Safety and Health Administration (OSHA) regulations.
3. Colored Red with White lettering.
4. 7-inches high by 10-inches wide.
5. Fastened with round head stainless steel screw or bolt.
6. Engraving for hinged access doors: “DANGER – 4,160 VOLTS - KEEP OUT”.
7. Engraving for accessible bolted plates: “DANGER – 4,160 VOLTS INSIDE”.

## **2.15 FABRICATION**

- A. Deliver motor control equipment to site ready for installation.
- B. Connect vertical sections together to form rigid lineups with flush front surfaces.
- C. Mount selector switches, pushbuttons, and meters to be readily accessible and no higher than 78-inches above finished floor or deck.
- D. Power factor correction capacitor controller may be integrated into cabinet of motor controller lineup or may be installed in separate enclosure, which is attached to motor controller lineup.
- E. Vertical Sections:
  1. 90-inches high, excluding the channel base.
  2. Mount low-voltage motor control equipment and terminal blocks within separate control section.
  3. Provide suitable back panel for mounting devices in low-voltage control section.
  4. Provide barriers in compartments to prevent contact with high voltage parts and to prevent tools from being dropped on high voltage parts.
  5. Medium-voltage power cables shall enter bottom of section. Allow adequate room for installation of stress cones.
  6. Cable entry from top of sections or bottom of sections.
- F. Doors:
  1. Provide single, hinged access doors on front of all compartments.
  2. Provide access doors with neoprene gaskets.
  3. Use two screws, minimum, to latch door. Screw head shall be large slotted, knurled knob. Provide keeper to prevent screw from falling out of door. Use of hex head screws will not be acceptable.
- G. Bus Fabrication:
  1. Support bus with molded glass-filled polyester insulating material.

2. Interconnect vertical section bus with horizontal bus, such that when they are bolted together, they become a continuous power bus.
  3. Ground Bus:
    - a. Material: Bare copper bar.
    - b. Run continuously along entire length of motor controller cubicles.
    - c. Accessible from front of cubicle.
    - d. Electrically bonded to starter metal enclosures.
    - e. Provide solderless, bolted type ground lug at each end of starter lineup.
- H. Terminal Blocks:
1. Mount terminal blocks at least 3-inches from panel edges and other devices. Mount adjacent rows of terminal blocks with 6-inches separation minimum. Access to terminal blocks shall be unobstructed.
  2. Identify vertical columns of terminal blocks with a single letter. Vertical columns may contain more than 12 termination points.
- I. Starter Wiring and Wiring Connections:
1. Wire motor controller as shown.
  2. Provide wiring duct system with removable covers for low-voltage wiring within starter. Covers shall be accessible for removal and replacement.
  3. Make all connections at device terminals or terminal blocks. Maximum two wires at terminations. Wire splices are not acceptable.
  4. Provide ring tongue pressure-crimp type connectors for terminations at electrical devices and terminal blocks. Use pin-type terminal connectors where use of ring tongues is not practical, such as terminations at selector switches, pushbuttons, indicating lamps, and auxiliary relays.
  5. Do not terminate wire without terminal connector.
  6. Terminate spare cable of multi-conductor control cable at terminal blocks.
- J. Wire Markers:
1. Provide wire marker on conductor end.
  2. Print conductor designation, as shown on approved schematic diagram, on first line. Print conductor destination and device terminal number on second line.
- K. Nameplates: Attach nameplates with pan head self-tapping screws. Do not use adhesives to attach nameplates.
- 2.16 FINISHES**
- A. Manufacturer's standard Grey finish.

- B. Interior of Low-Voltage Compartment: Painted white.

## **2.17 SOURCE QUALITY CONTROL**

- A. Factory Testing:
  - 1. Manufacturer's standard factory tests.
  - 2. Power frequency dielectric test.
  - 3. Operational test of control circuits.
  - 4. Point-to-point wiring checks.
- B. Factor Inspection:
  - 1. COR will inspect medium-voltage motor controllers prior to shipment to site.
  - 2. Notify COR in writing at least 14-days in advance of inspection date.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. In accordance with manufacturer's instructions and recommendations, and NEMA ICS 3.1.
- B. Perform under onsite supervision of a qualified original equipment manufacturer's erecting engineer.
- C. Tighten accessible bus connections and mechanical fasteners after placing motor controller.
- D. Terminate medium-voltage cable with cable terminators.
- E. Connect external wiring and cabling to fully integrate equipment with other systems in plant, and in accordance with approved drawings.
- F. Ground and bond motor controller lineup in accordance with Section 26 05 20 - Grounding and Bonding and as shown.
- G. Medium-voltage cable entry: From below motor control equipment via conduit.
- H. Set motor protection relay in accordance with motor manufacturer's recommendations.
- I. Set protective devices.
- J. Installation on Concrete Floor:
  - 1. Install motor control equipment on galvanized steel channel base.

2. Make channel base continuous around perimeter of equipment in accordance with drawings.
3. Provide channel base with holes for grout and anchors in accordance with drawings.
4. Set and level channel base on floor. Do not use shims to level channel base.
5. Bolt and grout channel base in place in accordance with Section 03 62 20 – Non-Shrink Grout for Equipment and Metalwork.
6. Bolt motor control equipment in place, on channel base, after grout has cured.
7. Furnish anchoring, supporting, and mounting materials required to install equipment.

### **3.02 FIELD QUALITY CONTROL**

#### **A. Field Testing:**

1. Perform field wiring checkout and test in accordance with Section 26 05 90 – Wiring Checkout and Tests.
2. Bus megger test.
3. Ground test.
4. Verification all mechanical interlocks are functioning properly.
5. Record settings of motor protection relay and other protective devices.

#### **B. Field Inspection: Prior to initial energization, inspect motor control equipment in accordance with NEMA ICS 3.1.**

### **3.03 ADJUSTING**

- #### **A. Adjust motor protective relay in accordance with relay settings furnished by Government.**

**END OF SECTION**

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**SECTION 26 22 12**  
**DRY-TYPE TRANSFORMER, KCA**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Dry-Type Transformer:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI C57.12.55 - 1987                      Dry-Type Transformers Used in Unit Installations, Including Unit Substations – Conformance Standard

B. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C57.96 – 1999                      Guide for Loading Dry-Type Distribution and Power Transformers

C. National Electrical Manufacturers Association (NEMA)

1. NEMA 250-2008                      Enclosures for Electrical Equipment (1,000 Volts Maximum)
2. NEMA TR 1-2013                      Transformers, Regulators and Reactors

D. National Fire Protection Association (NFPA)

1. NFPA 70-2011                      National Electrical Code (NEC)

**1.03 SUBMITTALS**

A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 - Electrical Drawings and Data.

B. RSN 26 22 12-1, Approval Data:

1. Manufacturer's technical data.
2. Equipment layout drawings.
3. Nameplate drawing.

C. RSN 26 22 12-2, Operation and Maintenance Instruction Book.

## **1.04 REGULATORY REQUIREMENTS**

- A. Be UL listed and bear the UL label.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store equipment in accordance with manufacturer's instructions. Include copy of these instructions with equipment at time of shipment.

## **PART 2 PRODUCTS**

### **2.01 208Y/120 VOLT SERVICE TRANSFORMER**

- A. Type: General purpose, self-cooled, dry-type.
- B. Enclosure: Ventilated, NEMA 250 Type 2 drip-proof. Fabricated of heavy gauge, sheet steel construction.
- C. Completed coil and core bolted to enclosure base isolated by means of rubber vibration-absorbing mounts.
- D. Provide electrostatic shield for attenuation of voltage spikes, line noise, and transients.
- E. Winding Conductors: Copper.
- F. Insulation: A 220-degree C system.
- G. Winding Temperature Rise: 150 degrees C above 40-degree C ambient.
- H. Primary Voltage: 480-volts, 3-phase, 60-hertz.
- I. Secondary Voltage: 208Y/120-volts, 3-phase, 60-hertz.
- J. kVA Rating: As shown.
- K. Primary Taps: Four 2.50 percent full-capacity below rated voltage and two 2.50 percent full-capacity above rated voltage.
- L. Mounting: Floor.

### **2.02 NAMEPLATES**

- A. Material: Type A as described on Standard Drawing 40-D-6234.
- B. Provide nameplate for each transformer.
- C. Engraving:
  - 1. "Transformer KCA – Feed Panelboard DCB".

**2.03 FINISHES**

- A. Manufacturer's standard Grey finish for intended installation location.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Furnish anchoring, supporting, and mounting materials required to install equipment.
- B. Install in accordance with manufacturer's instructions and recommendations.
- C. Minimum separation of at least 12-inches from any combustible materials,
- D. Make conduit and wiring connections.
- E. Transformer is separately derived alternating-current system as defined in NFPA 70. Ground and bond transformers in accordance with NFPA 70 and as shown.
- F. Provide require safety labels.
- G. Provide engraved nameplate on transformer.

**3.02 ADJUSTING**

- A. Measure primary and secondary voltages and make appropriate tap adjustments.

**END OF SECTION**

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## **SECTION 26 24 13 SWITCHBOARDS**

### **PART 1 GENERAL**

#### **1.01 MEASUREMENT AND PAYMENT**

A. Switchboards:

1. Payment: Lump sum prices offered in the Price Schedules.

#### **1.02 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI C12.20-2010 Electricity Meters 0.2 and 0.5 Accuracy Classes

B. National Electrical Manufacturers Association (NEMA)

1. NEMA 250-2014 Enclosures for Electrical Equipment (1,000 Volts Maximum)
2. NEMA FU 1-2012 Low-Voltage Cartridge Fuses
3. NEMA PB 2-2012 Deadfront Distribution Switchboards
4. NEMA PB 2.1-2007 General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less

C. National Fire Protection Association (NFPA)

1. NFPA 70-2017 National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL)

1. UL 50-2016 Enclosures for Electrical Equipment
2. UL 489-2013 Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
3. UL 891-2012 Switchboards

#### **1.03 DESIGN REQUIREMENTS**

- A. Design free-standing, dead-front type, low-voltage distribution switchboard that utilizes group mounted circuit breakers.

- B. Group mounted assemblies to consist of molded-case circuit breakers mounted on a panelboard type chassis.
- C. Switchboard design shall be suitable for both top and bottom cable entry.
- D. Switchboard design to include integrated automatic transfer switch that is fully compatible with engine-generator set. Transfers between normal service power and engine-generator shall be fully automatic.
- E. Switchboard design to include integrated panelboards to provide 480-volt power to the required loads.

#### **1.04 PROJECT CONDITIONS**

- A. Ambient Temperature Range: 0 to 40 degrees C.
- B. Pumping Plant No. 4; altitude: 5,900-feet.
- C. Pumping Plant No. 7; altitude: 6,300-feet.

#### **1.05 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 24 13-1, Approval Drawings and Data in Manufacturer's Format:
  - 1. Manufacturer's technical data.
  - 2. Equipment layout diagram.
  - 3. Nameplate list.
  - 4. Bill of materials.
- C. RSN 26 24 13-2, Approval Drawings in Government Format:
  - 1. Three-line Diagram.
  - 2. Schematic Diagrams.
  - 3. Wiring Diagrams.
- D. RSN 26 24 13-3, Factory Test Report.
- E. RSN 26 24 13-4, Check Prints:
  - 1. Schematic and wiring diagrams.
- F. RSN 26 24 13-5, Final Drawings.
- G. RSN 26 24 13-6, Operation and Maintenance Instruction Book:
  - 1. Provide for all equipment.

## **1.06 REGULATORY REQUIREMENTS**

- A. Be UL listed and labeled.
- B. Conform to NEMA PB 2, UL 50, UL 891, and NFPA 70.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store equipment in accordance with manufacturer's instructions. Include copy of these instructions with equipment at time of shipment.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Complete low voltage switchgear lineup fabricated by same manufacturer as Metal Clad Switchgear and Motor Control Equipment. Distributor or packager modifications to third-party standard product is not acceptable.
- B. Integrated facility system switchboard manufactured by Eaton; or equal having essential characteristics as shown below.

### **2.02 RATINGS**

- A. Switchboard Short-Circuit Rating: 65,000 symmetrical RMS amperes.
- B. Voltage Rating: 480/277-volts, 3-phase, 4-wire, 60-hertz.
- C. Through Bus: 800-amperes, RMS, minimum.
- D. Integrated Panelboards: As shown.

### **2.03 CONSTRUCTION**

- A. Switchboard consists of required number of vertical sections bolted together to form rigid assembly. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within enclosure.
- B. Enclosure Type: Type 1 in accordance with NEMA 250.
- C. All protective devices shall be group mounted as shown.
- D. All bus and device connections shall be accessible from front.
- E. Provide switchboard sections with adequate lifting means.

### **2.04 BUS**

- A. Bus Material: Manufacturer's standard plated copper.

- B. Provide full capacity neutral bus.
- C. Provide copper ground bus (minimum 1/4- x 2-inch).
- D. Provide bus joints with conical spring-type washers.

## **2.05 MOLDED CASE CIRCUIT BREAKER**

- A. Thermal-magnetic type with inverse-time trip characteristics on overload and instantaneous trip on short circuit.
- B. Voltage: 480/277-volts, as indicated.
- C. Frequency: 60-Hertz (Hz).
- D. Interrupting Rating: 25,000 symmetrical RMS amperes, minimum.
- E. Arc quenchers.
- F. Quick-make and quick-break toggle mechanisms.
- G. Trip-free operating handle.
- H. Single operating handle. Use of handle ties on multiple-pole circuit breakers is not acceptable.
- I. Equip with padlock attachments for locking breakers in "OFF" position.
- J. Shunt Trip: Intermittent rated solenoid with tripping plunger and cutoff switch assembled to plug-in module.
- K. Conform to UL 489.

## **2.06 AUTOMATIC TRANSFER SWITCH**

- A. Type: Automatic transfer, open transition.
- B. Number of Poles: Three.
- C. Current Rating: 400-amperes.
- D. Voltage Rating: 480-volts, 60-Hz.
- E. Enclosure: Mounted within NEMA 1 switchboard section.
- F. Switching panel shall consist of completely enclosed contact assemblies and separate control or transformer panel. Control power for all transfer operations shall be derived from line side of source to which load is being transferred.

- G. Transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources. Main contacts shall be mechanically locked in both normal and emergency positions. Neutral position shall not be possible under normal electrical operation.

## **2.07 TRANSFER SWITCH LOGIC CONTROLLER**

- A. Microprocessor-based. Controller shall be hardened against potential problems from transients and surges. Operation of transfer switch and monitoring of both sources shall be managed by controller.
- B. Provide controller display with the following unit status:
  - 1. Availability of NORMAL source.
  - 2. Availability of EMERGENCY source.
  - 3. Connection status of NORMAL source.
  - 4. Connection status of EMERGENCY source.
- C. Provide controller with pushbuttons for Engine Test, Engine Start, and System Test.
- D. Provide controller with the following features:
  - 1. Store set points in Non-Volatile memory. Use of an external battery source to maintain operation during “dead” periods is not acceptable.
  - 2. Monitor voltage of each phase of NORMAL source and EMERGENCY source and provide under-voltage dropout protection.
  - 3. Monitor frequency of NORMAL source and EMERGENCY source and provide under-frequency and over-frequency dropout protection.
- E. Provide controller with the following time-delay features:
  - 1. Selectable time delay on transfer to EMERGENCY source.
  - 2. Fixed time delay to override momentary power outage or voltage fluctuation.
  - 3. Fixed time delay on retransfer from EMERGENCY source to NORMAL source.
  - 4. Fixed time delay after retransfer that allows engine-generator to run unloaded prior to shut down.
  - 5. Fixed time delay for engine failure to start.
- F. Provide controller with one Form-A contact for closure of engine-generator start circuit.
- G. Capable of communicating to monitor all set points and operational characteristics using Modbus RTU.
- H. Include the following Historical Data Storage:
  - 1. Engine run time.

2. NORMAL source available time.
3. EMERGENCY source available time.
4. NORMAL source connected time.
5. EMERGENCY source connected time.
6. LOAD energized time.
7. Number of transfers.

## **2.08 POWER AND ENERGY METER**

- A. Eaton IQ 150 electronic power meter as manufactured by Eaton; or equal, having the following essential characteristics:
1. Microprocessor based and designed for multifunction electrical measurement on 3-phase power system.
  2. User programmable for voltage range to any PT ratio. Accept direct voltage input range of up to 416-volts line-to-neutral and 721-volts line-to-line.
  3. User programmable for current to any CT ratio and accept current input up to 11-amperes continuous.
  4. Provide true RMS measurements of voltage, phase-to-phase and phase-to-neutral; current, per phase and neutral.
  5. Accuracy: Plus, or minus 0.25 percent for volts, and 0.5 percent for power and energy functions.
  6. Provide Volts, Amps, VAR, VA, PF, Frequency, Watthours, VARh, and VAh.
  7. Provide meter with three-line LED display. Meter display to include a percent of FULL SCALE having not less than 10 segments.
  8. Be a traceable revenue meter, which contains a utility grade test pulse allowing power providers to verify and confirm the meter is performing to its rated accuracy.
  9. Provide meter with Modbus TCP communication format.
  10. Allow user to set up utility demand profile:
    - a. Readings for kW, kVAR, kVA, and PF calculated using utility demand features.
    - b. All other parameters have MAX and MIN capability over a user selectable averaging period.
    - c. Provide voltage with instantaneous MAX and MIN reading displaying the highest surge and lowest sag seen by meter.
  11. Meter capable of operating on a power supply of 90- to 265-volts, 60-Hz.
  12. Meter to be of same manufacturer and type as those provided in Section 26 18 39 – Medium-Voltage Motor Controllers.
  13. UL listed.

## 2.09 INSTRUMENT TRANSFORMERS

### A. Current Transformers:

1. Three single-phase; 60-hertz; single-ratio; single-secondary; indoor.
2. Voltage rating: 600-volts.
3. Basic impulse insulation level (BIL): 10-kilovolts.
4. Quantity and Ratio: As shown on drawings.
5. Class: C200.
6. Thermal Rating: 1 at 55 degrees C.
7. Short-time thermal-current rating: 40,000-amperes, minimum, (for 1-second).
8. Provide complete with necessary mounting devices, primary and secondary terminal studs, and secondary short-circuiting devices.
9. Provide shorting blocks for CT wiring that are UL recognized to 105 degrees C and are made up of thermoplastic body material.

### B. Potential Transformers:

1. Rated primary voltage: 480-volts.
2. Basic impulse insulation level: 10-kilovolts.
3. Quantity/Ratio: As shown. Rating: 200-VA, minimum.
4. ANSI metering accuracy classification and thermal burden ratings: Suitable for this application.
5. Provide complete with necessary mounting devices and primary and secondary terminal studs.
6. Fuses:
  - a. Current-limiting fuses in primary.
  - b. As indicated on drawings in potential transformer ungrounded secondary leads. Withstand maximum energizing current.
  - c. Locate in accessible areas.
  - d. Potential transformer primary circuit fuses and fuse holder ratings: 600-volts, current limiting with 3-pole block.
  - e. Potential transformer secondary circuit fuses and fuse holder ratings: 6-amperes, 250-volts, with 3-pole block.
  - f. UL listed.
  - g. Fuse-holders: Block type with side barriers.
  - h. Conform to NEMA FU 1.

## **2.10 SURGE PROTECTION DEVICE (SPD)**

- A. Utilize Metal Oxide Varistors (MOV).
- B. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system voltage.
- C. Protection Modes: Line to neutral (L-N), line to ground (L-G), and neutral to ground (N-G).
- D. Suppressed Voltage Rating (SVR): Not to exceed 800-volts for L-N, L-G, and N-G modes.
- E. LED indicators to show loss of protection and status of TVSS.
- F. Conform to NFPA 70, UL 1449, and be UL listed.

## **2.11 WIRING/TERMINATIONS**

- A. Provide control wiring, necessary fuse blocks, pushbuttons, switches, auxiliary relays, potential transformers, and terminal blocks within switchboard as required. Provide 15 percent spare terminals on each terminal block.
- B. Provide mechanical-type terminals for line and load terminations suitable for copper cable rated for 75 degrees C of size shown.
- C. Provide lugs in incoming line section for connection of main grounding conductor. Provide additional lugs for connection of other grounding conductors as required.
- D. Control wire shall be type SIS, bundled and secured with nylon ties.

## **2.12 NAMEPLATES**

- A. Nameplate:
  - 1. As indicated on standard drawing 40-D-6234.
  - 2. Provide nameplates for following:
    - a. Overall switchboard assembly: Manufacturer's nameplate:
      - 1) Place manufacturer's name, trademark, or other descriptive marking on all electrical equipment.
      - 2) Provide other markings: Voltage, current, wattage, or other ratings as specified.
    - b. Each section of switchgear assembly: Designations as indicated on drawings or as follows:
      - 1) Provide equipment designation nameplate for each section of switchboard.

- 2) Mount nameplates for each device on a door.
- 3) Nameplates for each device mounted within switchgear enclosure. In lieu of furnishing nameplates, Contractor may fulfill this requirement by identifying each device with device name or standard NEMA designation by a typed or computer-generated permanent marking on or adjacent to device.

## 2.13 FINISH

- A. Manufacturer's standard grey finish for intended installation location.

## 2.14 FABRICATION

- A. Form 480-volt station service switchboard into an integral assembly complete with channel base.
- B. Where welding is required, weld enclosures and sections along entire length of joint. Do not use skip-welding.
- C. Extend copper ground bus entire length of switchboard:
  1. Mechanically and electrically bond each vertical section.
  2. Equip with No. 4/0 AWG terminal for connection to building ground system.
  3. Drill and tap at 1-inch intervals for 8/32-inch screws.
- D. Provide spare circuit breakers as shown.
- E. Cover blank spaces with removable covers.
- F. All covers secured with captive screws.
- G. Internal Wiring:
  1. Wire control circuits in accordance with approved drawings and as necessary for equipment to function as required.
  2. Terminate all circuits that are required to be wired to external equipment on terminal blocks.
  3. Make wire terminations with ring tongues terminal connectors. Use pin type connectors where use of ring tongues is not practical such as terminations at selector switches, pushbuttons, indicating lamps, and auxiliary relays. Bare wire connections are not acceptable.
  4. Current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device.
  5. Form wiring into compact groups bound together and firmly supported. Run wiring straight, horizontally, or vertically with short-radius, right-angle bends. Twist hinge wiring around longitudinal axis of hinge, wherever practicable, instead of bending laterally.

6. Attach nameplates with pan head self-tapping screws. Do not use adhesives to attach nameplates.
7. Install grommets at holes in enclosure for wires and cables.
8. Do not splice wiring within switchboard.

## **PART 3 EXECUTION**

### **3.01 CONTRACTOR SOURCE QUALITY CONTROL**

#### **A. Factory Testing:**

1. Production (routine) tests on actual switchboard sections provided in accordance with NEMA PB 2.
2. Test circuits before shipment to demonstrate correctness of completed wiring connections and proper functioning of devices.
3. Job Hazard Analysis (JHA):
  - a. Provide when Government will be performing factory inspection.
  - b. Prepare JHA in accordance with 29 CFR 1910, Subpart I.
  - c. As a minimum include the following in JHA:
    - 1) Factory address and name of site visit contact person.
    - 2) Date of JHA.
    - 3) Purpose of JHA, for example "Visitor Safety Procedures."
    - 4) Hazards:
      - a) Types of hazards at factory.
      - b) Safety procedures in or around high-voltage test labs.
      - c) Safety procedures on factory floor.
    - 5) Personal protective equipment:
      - a) List of equipment required.
      - b) List of equipment provided by factory.
    - 6) Emergency response:
      - a) Name and phone number of Factory Safety Officer.
      - b) Employees trained in emergency conditions (CPR, First Aid).
      - c) Factory fire protection/evacuation procedures.
      - d) Nearest hospital or emergency room.
    - 7) Name, title and signature of factory official approving JHA.

### **3.02 SOURCE QUALITY ASSURANCE**

- A. Government reserves right to inspect equipment at supplier's manufacturing plant during fabrication and testing.

### **3.03 INSTALLATION**

- A. Install switchboard on a galvanized steel channel base:
  - 1. Make channel base continuous around perimeter of equipment in accordance with drawings.
  - 2. Provide channel base with holes for grout and anchors in accordance with drawings.
  - 3. Set and level channel base on floor. Use of shims to level channel base is not acceptable.
  - 4. Bolt and grout channel base in place in accordance with Section 03 63 00 – Epoxy Grout.
  - 5. Bolt motor control equipment in place on channel base after grout has cured.
  - 6. Furnish anchoring, supporting, and mounting materials required to install equipment.
- B. Install in accordance with manufacturer's instructions and recommendations.
- C. Ground and bond distribution board to existing grounding system in accordance with Section 26 05 20 - Grounding and Bonding.
- D. Make conduit and wiring connections.

### **3.04 CONTRACTOR FIELD QUALITY CONTROL**

- A. Automatic Transfer Switch:
  - 1. Coordinate testing with testing of engine-generator in Section 26 32 10 – Engine-Generator Set:
    - a. Sense failure of normal power source.
    - b. Send a start command to engine-generator set and have engine-generator set respond properly.
    - c. After a time delay, switch should sense proper voltage and frequency from generator then transfer load to generator.
    - d. Sense return of proper voltage of normal power source.
    - e. After a time delay, transfer load back to normal power source.
    - f. After stop time delay (cool down cycle), shut down engine-generator.
    - g. Control and run exercise cycle for engine-generator set.

**END OF SECTION**

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**SECTION 26 24 41**  
**DISTRIBUTION PANELBOARDS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Distribution Panelboards:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. National Electrical Manufacturers Association (NEMA)

1. NEMA 250-2014 Enclosures for Electrical Equipment  
(1,000 Volts Maximum)
2. NEMA PB 1-2012 Panelboards

B. National Fire Protection Association (NFPA)

1. NFPA 70-2017 National Electrical Code (NEC)

C. Underwriters Laboratories, Inc. (UL)

1. UL 67-09 Panelboards
2. UL 489-13 Safety Molded-Case Circuit Breakers,  
Molded-Case Switches, and Circuit-Breaker  
Enclosures

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals and Section 01 33 26 - Electrical Drawings and Data.

B. RSN 26 24 41-1, Approval Data:

1. Manufacturer's Technical Data.

C. RSN 26 24 41-2, Approval Layouts:

1. Equipment Layout Drawing.

D. RSN 26 24 41-3, Test Data.

**1.04 REGULATORY REQUIREMENTS**

A. UL listed and labeled.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store equipment in accordance with manufacturer's instructions. Include copy of these instructions with equipment at time of shipment.

## **PART 2 PRODUCTS**

### **2.01 480 VOLT DISTRIBUTION PANELBOARDS**

- A. Voltage and System: 480 volts, 3-phase, 4-wire, 60-hertz.
- B. Input Type: Main Circuit Breaker (MCB)
- C. Main Bus Rating: 250-amperes, minimum.
- D. Enclosure Type:
  - 1. Chemical Building: NEMA 250 Type 4.
  - 2. Turnout Building: NEMA Type 12.
- E. Solid neutral bus.
- F. Bus Material: Copper.
- G. Mounting: Surface-mounted.
- H. Accessories:
  - 1. Integrated surge protection device.
  - 2. Ground bus:
    - a. Copper.
    - b. Sufficient length for attaching equipment ground conductors.
  - 3. Circuit directory:
    - a. Show breaker number and connected load as shown on drawings.
    - b. Provide panelboard schedule on drawings unless as-built conditions require directory to be revised.
    - c. Use computer generated lettering in capital letter for directory entries.
    - d. Directory to provide the following information:
      - 1) Panel name.
      - 2) AIC Rating.
      - 3) Feeding circuit number and panel name.
      - 4) Volts, Amps, Phase, Wire, and Date printed.

- I. Nameplate:
  - 1. As indicated on standard drawing 40-D-6234.
  - 2. Provide nameplate for each Panelboard.
  - 3. Engraving:
    - a. Chemical Building: "S0504-PNL-001".
    - b. Turnout Building: "S0505-PNL-001".
- J. Conform to NEMA PB-1, UL 67, and NFPA 70.
- K. Finish: Manufacturer's standard Grey finish for intended installation location.

## **2.02 208/120 VOLT DISTRIBUTION PANELBOARD**

- A. Voltage and System: 208/120 volts, 3-phase, 4-wire, 60-hertz.
- B. Input Type: Main Lug Only (MLO).
- C. Main Bus Rating: 225-amperes, minimum.
- D. Enclosure Type: In accordance with NEMA 250 Type 12 with hinged door.
- E. Solid neutral bus.
- F. Bus Material: Copper.
- G. Mounting: Surface-mounted.
- H. Accessories:
  - 1. Ground bus:
    - a. Copper.
    - b. Sufficient length for attaching equipment ground conductors.
  - 2. Circuit directory:
    - a. Show breaker number and connected load as shown on drawings.
    - b. Provide panelboard schedule on drawings unless as-built conditions require directory to be revised.
    - c. Use computer generated lettering in capital letter for directory entries.
    - d. Directory to provide the following information:
      - 1) Panel name.
      - 2) AIC Rating.
      - 3) Feeding circuit number and panel name.
      - 4) Volts, Amps, Phase, Wire, and Date printed.

- I. Nameplate:
  - 1. As indicated on standard drawing 40-D-6234.
  - 2. Provide nameplate for each Panelboard.
  - 3. Engraving:
    - a. “S0503-PNL-001”.
- J. Conform to NEMA PB-1, UL 67, and NFPA 70.
- K. Finish: Manufacturer’s standard Grey finish for intended installation location.

### **2.03 LIGHTING DISTRIBUTION PANELBOARD**

- A. Voltage and System: 480/277 volts, 3-phase, 4-wire, 60-hertz.
- B. Enclosure Type: In accordance with NEMA 250 Type 1 with hinged door.
- C. Mounting: Surface-mounted.
- D. Accessories:
  - 1. Integrated Lighting Control PLC:
    - a. Local programming.
    - b. LCD touchscreen.
    - c. Master override.
    - d. Time schedules with astronomic clock.
    - e. Onboard ethernet port.
  - 2. Dry contact inputs:
    - a. Quantity: 16 (minimum).
    - b. Wall switch.
    - c. Photocell.
    - d. Occupancy sensor.
  - 3. Circuit directory:
    - a. Show circuit number and connected load as shown on drawings.
    - b. Provide schedule on drawings unless as-built conditions require directory to be revised.
    - c. Use computer generated lettering in capital letter for directory entries.
    - d. Directory to provide the following information:
      - 1) Panel name.
      - 2) AIC Rating.
      - 3) Feeding circuit number and panel name.
      - 4) Volts, Amps, Phase, Wire, and Date printed.

- E. Nameplate:
  - 1. As indicated on standard drawing 40-D-6234.
  - 2. Provide nameplate for each Panelboard.
  - 3. Engraving:
    - a. “S0502-LCP-001.
- F. Conform to NEMA PB-1, UL 67, and NFPA 70.
- G. Finish: Manufacturer’s standard Grey finish for intended installation location.

#### **2.04 MOLDED CASE CIRCUIT BREAKER**

- A. Thermal-magnetic type with inverse-time trip characteristics on overload and instantaneous trip on short circuit.
- B. Voltage: 208/120 volts, as required.
- C. Single or multi-pole as indicated on panelboard schedules.
- D. Frequency: 60-hertz.
- E. Interrupting Rating: 14,000 symmetrical RMS amperes, minimum.
- F. Arc quenchers.
- G. Quick-make and quick-break toggle mechanisms.
- H. Trip-free operating handle.
- I. Circuit breakers shall be lockable where required by other systems such as Fire Protection System. See Section 28 31 00 – Fire Detection and Alarm. A lockable breaker is accomplished by using circuit breaker lock that is listed for use with circuit breaker and that allows breaker to trip but does not allow tampering with breaker.
- J. Single operating handle. Use of handle ties on multiple-pole circuit breakers is not acceptable.
- K. Equip with padlock attachments for locking breakers in “OFF” position.
- L. Conform to UL 489.

#### **2.05 SURGE PROTECTION DEVICE (SPD)**

- A. Utilize metal oxide varistors (MOV).
- B. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system voltage.

- C. Protection Modes: Line to neutral (L-N), line to ground (L-G), and neutral to ground (N-G).
- D. Suppressed Voltage Rating (SVR): Not to exceed 800 volts for L-N, L-G, and N-G modes.
- E. LED indicators to show loss of protection and status of TVSS.
- F. Conform to NFPA 70, UL 1449, and be UL listed.

## **2.06 FABRICATION**

- A. Mount ground bus at bottom of panelboard enclosure. Bond bus to enclosure.
- B. Mount circuit directory on inside of door.
- C. Provide spare circuit breakers as shown.
- D. Cover blank spaces with removable covers.
- E. Circuit Directory:
  - 1. Use computer generated lettering for directory entries. Hand written directory entries are not acceptable.
  - 2. Show breaker number and connected load as indicated in their relative physical location.
  - 3. Provide panelboard schedule on drawings unless as-built conditions require directory to be revised.
  - 4. Mount directory in transparent plastic front on inside surface of access doors for each board.
  - 5. Fabricate circuit directory frame such that directory need not be folded when placed in frame, and such that all information on directory is clearly visible and legible.
  - 6. Directory to provide the following information:
    - a. Panel name.
    - b. AIC Rating.
    - c. Supply circuit number and panel name.
    - d. Volts, Amps, Phase, Wire, and Date printed.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Provide anchoring, supporting, and mounting materials for a complete installation.

- B. Install in accordance with manufacturer's instructions and recommendations.
- C. Panelboard shall be mounted so that no operating handle is less than 24-inches or more than 72-inches above finished floor.
- D. Set panelboard plumb and level.
- E. Make conduit and wiring connections.
- F. Provide require safety labels.
- G. Provide engraved nameplate on panelboard.
- H. See Section 26 56 00 – Exterior Lighting for lighting control scheduling.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Panelboard enclosure key shall be shown to operate in presence of government representative.
- B. Provide test equipment, labor, and personnel as required to perform the following tests. Panelboards shall be given continuity and insulation tests after installation has been completed and before panelboard is energized:
  - 1. Continuity tests using dc device with buzzer.
  - 2. Insulation test using 500-volt minimum insulation-resistance test set:
    - a. Record readings after 1-minute and until readings are constant for 15-seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.
  - 3. Record test data and include identification of panelboard and megohms readings.

**END OF SECTION**

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**SECTION 26 26 10**  
**TRANSFORMER LOAD CENTER**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Transformer Load Center:

1. Include in lump sum price offered in Price Schedule 1 (Pumping Plant No. 4).

**1.02 REFERENCE STANDARDS**

A. National Electrical Manufacturers Association (NEMA)

1. NEMA 250-2008 Enclosures for Electrical Equipment  
(1,000 Volts Maximum)

B. Institute of Electrical and Electronic Engineers, Inc. (IEEE)

1. IEEE C57.96-1999 IEEE Guide for Loading Dry-Type  
Distribution and Power Transformers

C. National Fire Protection Association (NFPA)

1. NFPA 70-2011 National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL)

1. UL 489-2002 Safety Molded-Case Circuit Breakers,  
Molded-Case Switches, and Circuit-Breaker  
Enclosures

**1.03 SUBMITTALS**

A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.

B. RSN 26 26 10-1, Approval Data:

1. Manufacturer's technical data.

C. RSN 26 26 10-2, Panelboard Schedule and Circuit Directory.

**1.04 DELIVERY, STORAGE, AND HANDLING**

A. Handle and store equipment in accordance with manufacturer's instructions and recommendations and in a manner to avoid damage to internal components, metal enclosure, and finish.

- B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect equipment from dirt, water, and construction debris.

## **PART 2 PRODUCTS**

### **2.01 RATINGS**

- A. Load: As shown.
- B. Voltage and System: 480-120/240 volt, 1-phase, 60 Hz.
- C. Unit designed for continuous operation at rated kVA with normal life expectancy as define in IEEE C57.96.
- D. Transformer sound levels not to exceed the following ANSI and NEMA levels for self-cooled ratings:
  - 1. Up to 9 kVA: 40 db.
  - 2. 10 to 30 kVA: 45 db.

### **2.02 CONSTRUCTION**

- A. Provided with primary main breaker, an encapsulated dry-type transformer and panelboard with secondary main breaker.
- B. Primary main, secondary main and branch-circuit breakers enclosed with a pad-lockable hinged door.
- C. Suitable for service entrance application.
- D. Transformer Windings and Insulation Systems:
  - 1. Transformer windings electrical grade copper.
  - 2. Transformer insulated with 185 degrees C insulation system and rated at 115 degrees C temperature rise.
  - 3. Primary Taps: Two 5 percent full-capacity below rated voltage.
- E. UL listed.

### **2.03 BUS**

- A. Secondary Bus: Copper.

### **2.04 LOADCENTER**

- A. Copper chassis suitable for either bolt-on or plug-in branch circuit breakers.
- B. Space for at least 18 single-pole breakers.

- C. Ground bar for grounding individual branch circuits.
- D. Neutral bar bonded to enclosure.
- E. Accessories:
  - 1. Circuit Directory: Show breaker number and connected load.

## **2.05 WIRING/TERMINATIONS**

- A. Interconnecting wiring between primary breaker and transformer, secondary main breaker and transformer and distribution section shall be factory installed.
- B. Provide transformer load center with wiring compartment suitable for conduit entry and enough space to allow convenient wiring.

## **2.06 CIRCUIT BREAKERS**

- A. Thermal-magnetic type with inverse-time trip characteristics on overload and instantaneous trip on short circuit.
- B. Interrupting Rating: 14,000 symmetrical RMS amperes at 480V and 10,000 symmetrical RMS amperes at 120/240V, minimum.
- C. Quick-make and quick-break toggle mechanisms.
- D. Trip-free operating handle.
- E. Single operating handle. Use of handle ties on multiple-pole circuit breakers is not acceptable.
- F. Conform to UL 489.

## **2.07 ENCLOSURE**

- A. Totally enclosed, nonventilated, NEMA 3R, with lifting eyes.
- B. Constructed from heavy-gauge sheet steel.
- C. Finish: Manufacturer's standard grey coating.

## **2.08 SOURCE QUALITY CONTROL**

- A. Perform factory production tests in accordance with manufacturer's standard shop and quality control procedures.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install transformer load center as shown.
- B. Install in accordance with manufacturer's instructions and recommendations and in a location approved by COR.
- C. Set transformer load center plumb and level.
- D. Height: 6-feet to top of load center.
- E. Connect external wiring and conduit.
- F. Ground and bond transformer load center in accordance with Section 26 05 20 – Grounding and Bonding and NFPA 70.
- G. Mount circuit directory on inside of loadcenter door.

### **3.02 ADJUSTING**

- A. Measure primary and secondary voltages and make appropriate tap adjustments.

### **3.03 CLEANING**

- A. Clean interior of transformer load center to remove construction debris, dirt, and shipping materials.

**END OF SECTION**

**SECTION 26 27 40**  
**WIRING DEVICES**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Wiring Devices:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. National Electrical Manufacturers Association (NEMA)

1. NEMA WD 1-2016 General Color Requirements for Wiring Devices
2. NEMA WD 6-2012 Wiring Devices - Dimensional Requirements

B. Underwriters Laboratories Inc. (UL)

1. UL 20-2010 General Use Snap Switches
2. UL 94-2013 Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

**1.03 SUBMITTALS**

A. Submit in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.

B. RSN 26 27 40-1, Approval Data:

1. Manufacturer's data.

**PART 2 PRODUCTS**

**2.01 OCCUPANCY SENSOR LIGHT SWITCH**

A. Manual-On Occupancy Sensor manufactured by Leviton, [www.leviton.com](http://www.leviton.com), Catalog# OSSMT-MDW; or equal, having the following essential characteristics:

1. Switch shall be capable of manual-on and automatic-off operation via passive infrared (PIR) and ultrasonic (U/S) detection technology to monitor occupancy space.

2. If this unit does not detect movement after a preset period of time, it will respond by switching its assigned load off.
3. Device shall switch at zero crossing point of AC power curve to ensure maximum relay contact life and compatibility with electronic ballasts.
4. Manual-on occupancy sensor shall be equipped with push-button to provide manual on/off switching.
5. Device shall feature adjustable delayed-off time as well as provide sensitivity adjustment and integral sliding blinders to customize horizontal field of view.
6. Field of view shall be 180 degrees with maximum coverage of 2,400 square feet.
7. Sensing distance shall be a minimum of 40-feet in front and 30-feet to the sides.
8. Four optional manual adjustments for delayed-off time setting: 30-seconds, 10-minutes, 20-minutes, and 30-minutes.
9. All adjustment options are made after removing control panel cover.
10. Device shall be capable of providing optional manual-on/automatic-off operation. If motion is detected within 40-seconds after load has been turned off due to absence of motion, lights will turn back on. If 40-seconds expires, lights (load) must be turned on manually.
11. Device shall be capable of controlling load in single pole applications as indicated.
12. Frequency: 60-hertz.
13. Voltage: 277 VAC.
14. Load rating: 2700 volt-amperes (VA) at 277-voltage for fluorescent loads.
15. Color: White.
16. Conform to NEMA WD 1 and be UL listed.

## **2.02 TOGGLE LIGHT SWITCH**

- A. AC Switches manufactured by Leviton, [www.leviton.com](http://www.leviton.com), Catalog # 1221-SW, 1223-SW, and 1224-SW; or equal, having the following essential characteristics:
  1. Industrial grade.
  2. Toggle switch.
  3. Current: 20-amperes.
  4. Single pole, 3-way, or 4-way operation as indicated.
  5. Contacts: Silver-cadmium 0.031 thick.
  6. Operating temperature: Minus 40 to 65 degrees C.
  7. Flame resistance to V-0 rating per UL 94.
  8. Frequency: 60-hertz.

9. Voltage: 120/277 VAC.
10. Color: White.
11. Terminals: Capable of #10 wiring.
12. Conform to NEMA WD 1 and WD 6.
13. UL listed, meeting the requirements of UL 20.

### **2.03 LOW VOLTAGE SWITCH**

- A. Pow-R-Command Low Voltage Switch manufactured by Eaton, Website: [www.eaton.com](http://www.eaton.com), Catalog #: PRC-LS-2-W; or equal, having the following essential characteristics:
1. Compatible with selected lighting control panel per Section 26 24 41.
  2. Push-button switch.
  3. 2 button.
  4. Operating temperature: -40 degrees Celsius to 40 degrees Celsius.
  5. Terminals: 18 AWG wiring.

### **2.04 RECEPTACLES**

- A. 120-volt Type:
1. Specification grade, heavy duty, duplex plug.
  2. NEMA Configuration: 5-20R.
  3. Frequency: 60-hertz.
  4. Current: 20-amperes.
  5. Device Body: Impact resistant plastic.
  6. Terminals: Screw type for line wiring and grounding.
- B. Conform to NEMA WD 1, NEMA WD 6, and be UL listed.

### **2.05 GFCI RECEPTACLES**

- A. Specification grade, heavy duty, duplex plug with integral ground fault circuit interrupter.
- B. NEMA Configuration: 5-20R.
- C. Voltage and frequency: 120-volts, 60-hertz.
- D. Current: 20-amperes.
- E. Body: Impact resistant plastic.
- F. Terminals: Screw type for line wiring and grounding.

- G. Pushbuttons: Test and reset.
- H. Conform to NEMA WD 1 and NEMA WD 6.

## **2.06 POWER RECEPTACLES**

- A. Interlocked Receptacle manufactured by Copper Crouse-Hinds, [www.crouse-hinds.com](http://www.crouse-hinds.com), Catalog # CSR63542; or equal, having the following essential characteristics:
  - 1. Type: Heavy duty, NEMA 4X, corrosion/impact resistant enclosure.
  - 2. Configuration: 3-wire, 4-pole, Non-Fused, with mechanical interlock and disconnect switch.
  - 3. Rated Voltage: 600-volts.
  - 4. Rated Current: 60-amperes.
  - 5. Provided with threaded cap with chain.
  - 6. UL listed.

## **2.07 COVER PLATES**

- A. Standard Switch and Receptacle:
  - 1. Type: Impact resistant plastic with white cover plate or 302 stainless steel as indicated.
  - 2. Material Thickness: 0.032-inches.
  - 3. Switch cover plates shall have number of gangs as indicated.
- B. Weatherproof Switch Cover-plates:
  - 1. Type: Die cast with heavy rubber gasket.
  - 2. Material: Copper free aluminum.
  - 3. Suitable for mounting on type FS cast box.
  - 4. Manufacturers: Crouse Hinds, Syracuse NY, Catalog No. DS 185; or equal.
- C. Weatherproof Receptacle Cover-plates:
  - 1. Type: Die cast with heavy rubber gasket.
  - 2. Material: Copper free aluminum.
  - 3. Suitable for mounting on type FS cast box.
  - 4. Cover shall be 'in-use' type cover meeting requirements of NFPA 70.

## **2.08 FINISHES**

- A. Manufacturer's standard finishes except as follows:
  - 1. Light Switches and all Receptacles: White.
  - 2. Standard Cover Plates: White.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Bond wiring devices to equipment grounding conductor.
- B. Provide wiring devices as indicated.
- C. Install switches with OFF position down.
- D. Install duplex receptacles in single gang back boxes. Install quad receptacles as 2 duplex receptacles in 1 double gang back box with 1 quad receptacle faceplate.
- E. Install receptacles with grounding pole on top.
- F. Set occupancy sensor switches to a 10-minute time delay for shut off.
- G. Install fork pressure-crimp-type connectors for terminations. Do not place bare stranded conductors directly under screws. Do not use push-in terminals for wiring connections.

**END OF SECTION**

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**SECTION 26 32 10**  
**ENGINE-GENERATOR SETS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Diesel Engine-Generator Set at Pumping Plant No. 4:
1. Payment: Lump sum price offered in Price Schedule 1 (Pumping Plant No. 4).
- B. Diesel Engine-Generator Set at Pumping Plant No. 7:
1. Payment: Lump sum price offered in Price Schedule 2 (Pumping Plant No. 7).

**1.02 REFERENCE STANDARDS**

- A. Commercial Item Description (CID)
1. CID A-A-1923A Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
- B. National Electrical Manufacturer's Association (NEMA)
1. NEMA 250-2014 Enclosures for Electrical Equipment (1,000 Volts Maximum)
  2. NEMA MG 1-2016 Motors and Generators
- C. National Fire Protection Association (NFPA)
1. NFPA 30-2018 Flammable and Combustible Liquids Code
  2. NFPA 54-2018 National Fuel Gas Code
  3. NFPA 70-2020 National Electrical Code
  4. NFPA 90A-2018 Installation of Air Conditioning and Ventilating Systems
  5. NFPA 110-2019 Emergency and Standby Power Systems
- D. Underwriters Laboratories, Inc. (UL)
1. UL 142-2019 Steel Aboveground Tanks For Flammable and Combustible Liquids
  2. UL 1236-2015 Battery Chargers for Charging Engine-Starter Batteries

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals, and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 32 10-1, Approval Drawings and Data for Engine-Generator Sets and Diesel Fuel Tanks:
  - 1. Commercial product data for components furnished.
  - 2. Detailed shop drawings for components furnished.
  - 3. Electrical control diagrams, interconnections wiring diagrams, and schematics showing wire connections and conduit layout. Provide electrical control schematic diagrams in ladder-logic format.
- C. RSN 26 32 10-2, Final Drawings and Data:
  - 1. Service manuals for components furnished:
    - a. Operating and maintenance instructions.
    - b. Half-size prints (11- x 17-inches) of installation and detailed assembly drawings.
    - c. Electrical schematics and wiring diagrams.
    - d. Lubrication schematics and wiring diagrams.
    - e. Lubrication schedule.
    - f. List of special tools.
    - g. Parts catalog for components provided under this section.
  - 2. Electronic copies of drawings and diagrams submitted in the service manual in AutoCAD format.
  - 3. Site test procedures for on-site testing and provide NFPA 110 requirements.
- D. RSN 26 32 10-3, Site Test Report and Photographs:
  - 1. Certified copies of mechanical and electrical site tests.
  - 2. Photographs: Include one side view and one end view of installed engine-generator set, and one view showing the fuel tank system after installation.

### **1.04 EXTRA MATERIALS**

- A. Furnish the following spare parts in a metal box for each engine-generator set:
  - 1. Four engine oil filters.
  - 2. Four air filter elements.
  - 3. One complete set of engine V-belts.
  - 4. Six spare fuses of each type of fuse.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Protect equipment from corrosion, deformation, and other types of damage.

**PART 2 PRODUCTS****2.01 ENGINE-GENERATOR SETS (EACH)**

- A. Outdoor, stationary unit complete with weather-protective housing, and rated for standby service.
- B. Engine and main generator both mounted to rigid frame with vibration isolators sized for continuous full-load operation. Vibration isolators between fuel tank and engine-generator set.
- C. Fully operational system with associated control and electrical equipment installed complete.
- D. Nameplate Rating:
1. Rating, minimum after derating: 250 kW (313 kVA).
  2. Ambient air temperature range: -10 to 110 degrees F.
  3. Elevation, above sea level:
    - a. Pumping Plant No. 4: 5,900.
    - b. Pumping Plant No. 7: 6,300.
- E. Engine:
1. 4-Cycle.
  2. Fuel: Diesel
  3. Speed: 1,800 rpm.
  4. Starting system: 12-volt DC.
  5. Governor: Electronic, isochronous.
  6. Cooling system: Closed recovery, liquid coolant, with a unit-mounted radiator, belt-driven pusher fan, thermostatic temperature control, and engine-mounted circulating pump.
- F. Power factor: 0.8 power factor.
- G. Voltage: 277/480 volts.
- H. Phase: 3-phase.
- I. Frequency: 60-hertz.

- J. Alternator:
  - 1. Capable of operation at full rated load without exceeding 150 degrees C (257 degrees F) temperature rise as defined by NEMA Standard MG1 for ambient temperatures above 40 degrees C (104 degrees F).
  - 2. Winding insulation: NEMA MG1, Class H.
- K. Voltage Regulator: Torque-matched with under-frequency and over-voltage protection and 3-phase voltage sensing.
- L. Excitation System:
  - 1. Brushless.
  - 2. Shaft mounted.
- M. Frequency Regulation: Isochronous for all applied loads from no load to full-rated load.
- N. Random Frequency: Plus, or minus 0.5 percent of its mean value for constant loads, from no load to full-rated load.
- O. Transient Voltage Dip: Not to exceed 20 percent of the rated voltage.
- P. Steady-state Frequency: Voltage output shall be constant.
- Q. Voltage Regulation: Plus, or minus 1 percent between no load and full-rated load.

## **2.02 ASSOCIATED COMPONENTS**

- A. Circuit Breaker
  - 1. Type: Molded-case, thermal-magnetic.
  - 2. Manual reset circuit.
- B. Battery:
  - 1. Voltage: 12-volt DC.
  - 2. Type: Lead-acid.
  - 3. Cranking Current: 550 amps (minimum) at ambient temperature of 32 degrees F.
  - 4. Life expectancy: 4-years on float charge.
  - 5. Insulation: Size and type recommended by battery manufacturer.
  - 6. Rack mounted in engine-generator weather-protective housing.
  - 7. Accessories: One set of cables and connectors of engine-generator manufacturers recommended size and type.
- C. Battery Charger:
  - 1. Voltage: 12-volts DC.

2. Current: 40-amperes (minimum) and tapering to 0-ampere.
  3. Service power: 120-volts, single phase, 60-hertz.
  4. Meters: Direct-current voltmeter and ammeter, accuracy within 2 percent of full scale with an independently adjustable float and equalize charge.
  5. Protect input and output circuits of battery charger with circuit breaker (or fuses).
  6. Enclosure: NEMA 250, Type 3R.
  7. Rack mounted with battery in engine-generator weather-protective housing and isolated from engine-generator set.
  8. Designed for heavy-duty industrial service.
  9. DC voltage regulation: Plus or minus 1 percent, from no load to full load.
  10. Integrated with battery heater suitable for ambient conditions.
  11. In accordance with requirements of UL 1236
- D. Heaters for Coolant and Battery:
1. Service power: 120-volts, single phase, 60-hertz.
  2. Size: Manufacturer's standard for specified site conditions
  3. Thermostatically controlled, as recommended by manufacturer.
- E. Digital Electronic Control Panel:
1. Circuitry: Solid-state.
  2. Mounting: Provide vibrational isolators.
  3. Schematic Wiring Diagrams:
    - a. Attach to inside of control panel cabinet door.
    - b. Show relationship and location of controls and alarm contacts.
  4. Selector switch and pushbuttons (or equivalent electronic controls):
    - a. Three position selector switch (labeled OFF-MANUAL-AUTOMATIC):
      - 1) MANUAL position: Manual startup or shutdown of engine-generator set in response to START-STOP pushbuttons.
      - 2) OFF position: Prevents manual or automatic operation of engine-generator set and provides lockout safety for periodic maintenance and resetting of engine-generator set.
      - 3) AUTOMATIC position: Starting and operating engine-generator set in response to automatic engine-starting system controls from automatic transfer switch in accordance with Section 26 24 13 – Switchboards, DCA.
    - b. START-STOP pushbuttons.

- c. Emergency stop pushbutton or switch:
    - 1) Cause engine-generator set to immediately shut down and be locked out from automatic restarting.
    - 2) Include lockout provision for use in safely disabling engine-generator set for necessary service.
  - d. Fault reset switch: Clears fault and allows restarting of engine-generator set after shut-down for any fault condition.
5. Indicators:
- a. Running time meter (hours) to log actual engine operation.
  - b. Oil pressure.
  - c. Oil temperature.
  - d. Engine coolant temperature.
  - e. 3-phase AC current.
  - f. Line-to-line and line-to-neutral AC volts.
  - g. Frequency.
  - h. Total and individual phase kW and kVA.
  - i. Fuel-level indication meter.
- F. Alarm Contacts and Illuminated Annunciation Lamps:
- 1. Alarm contacts wired to terminal blocks in engine-generator set control panel, to close and indicate the following conditions:
    - a. Engine-generator set fail to crank shutdown.
    - b. Engine-generator set fail to start (overcrank) shutdown.
    - c. Engine-generator set overspeed shutdown.
    - d. Engine-generator set high coolant temperature shutdown.
    - e. Engine-generator set low coolant temperature alarm.
    - f. Engine-generator set low oil pressure shutdown.
    - g. High, low, and weak battery voltage alarm.
    - h. High and low AC voltage shutdown.
    - i. Under frequency shutdown.
    - j. Short circuit shutdown.
    - k. Ground fault alarm.
    - l. Over load alarm.
    - m. Low fuel level in fuel sub-base tank.

G. Cranking Controls:

1. Cranking limiter: Prevent simultaneous engine cranking and engine operation.
2. Oil-pressure bypass switch: Bypass engine oil-pressure protective switch for duration of cranking interval to permit engine-generator set startup.

H. Shutdown Controls:

1. High engine coolant temperature.
2. Low coolant level.
3. Low oil-pressure.
4. Overspeed.
5. Failure to start after stipulated number of cranking attempts.
6. Failure to crank.
7. High and low AC voltage shutdown.
8. Under frequency shutdown.
9. Short circuit shutdown.

I. Exhaust System:

1. Directs all engine exhaust to outside weather-protective housing for engine-generator set.
2. Flexible exhaust connector:
  - a. Spiral or bellows type.
  - b. Locate between discharges of engine exhaust and exhaust system to isolate vibration.
3. Exhaust piping: Carbon steel with sweeping long-radius elbows.
4. Rain cap: Install on discharge end of exhaust pipe.
5. Condensation trap and drain valve: Install between flexible exhaust connector and muffler.
6. Muffler: Rated for critical noise applications. Weight of muffler shall be supported by weather-protective housing.
7. Heat shield: Provide around exhaust piping to prevent accidental burns.

J. Weather-Protective Housing:

1. Commercial unit specifically designed for engine-generator set supplied.
2. Fabricated steel framework and panels, with properly sized vents for dissipating engine heat.
3. Removable panels or hinged doors on both sides of housing to provide access to engine-generator set, load bank, batteries, battery charger, control panel, subbase fuel tank fill and drain lines, and tank monitoring and detecting systems. All service points to be accessible.

4. Anchor to concrete foundation with expansion anchors on rigid steel base, independent of enclosed engine-generator set.
5. Louvers: Sized to meet engine-generator set manufacturer's requirements.
6. Flexible section: Provide flexible duct section between load bank and weather-protective housing in accordance with NFPA 90A.

K. Resistive Load Bank:

1. Operates in conjunction with automatic transfer switch and engine-generator controls.
2. Used for testing and exercising engine-generator.
3. Load bank rating: 125 kW, 1.0 power factor, minimum.
4. Enclosure: NEMA 250, Type 3R.
5. Air cooled and mounted directly to radiator.
6. Voltage rating: Three-phase, 60-hertz, 208-volts.
7. Provide magnetic contacts for disconnection.
8. Provide comprehensive circuit fuse protection of load bank controls.
9. Provide resistive elements from output of engine-generator set.
10. One alarm contact to indicate over-temperature of load bank.

L. Fuel System:

1. Comply with applicable rules and regulations of NFPA 30, NFPA 54 and shall meet all prevailing Federal, State, tribal, and local codes governing this type of installation.
2. Fuel pipe system:
  - a. Seamless flexible supply and return lines between sub-base fuel tank and engine-generator set.
3. Diesel fuel sub-base storage tank:
  - a. Double wall (secondary containment), aboveground, steel fuel tank.
  - b. Inner tank size: At least 36-hour capacity at engine-generator set full rated load.
  - c. In accordance with requirements of UL 142.
  - d. Leak detector tube to allow monitoring capability between primary and secondary containment walls.
  - e. Interstitial leak detection with alarm system.
  - f. Emergency, secondary, and normal vent piping with rain cap, necessary nipples, and threaded steel pipe.
  - g. Overfill spill containment.

- h. Float-operated automatic shutoff valve to provide overflow protection.
- i. Fuel level indicator:
  - 1) Float and arm type.
  - 2) Resistant output from potentiometer which is linear and proportional to level in tank.
  - 3) Suitable for diesel fuel.
  - 4) On-site digital indication in gallons or percent.
  - 5) Low-level fuel warning light, part of engine-generator set control panel.
  - 6) Supply power: 120-volts, single phase, and 60-hertz.

### **2.03 EXPANSION ANCHORS**

- A. Expansion Anchors:
  - 1. CID A-A-1923A, Type 4, galvanized steel.
  - 2. Bolt length: 3 1/2-inch minimum embedment or manufacturer's minimum embedment, whichever is greater.

### **2.04 ELECTRICAL EQUIPMENT**

- A. Furnish all cables, conduits, terminations, and accessories required for interconnecting equipment included in this section and in accordance with Division 26 – Electrical.
- B. Power and Control Cables: Designed for outdoor use, with water, oil, and ultraviolet-light resistant cable jacket.

### **2.05 NAMEPLATE**

- A. Location: Attached to control panel.
- B. Inscribe the following:
  - 1. Ratings: Kilowatt and kVA, rpm, three-phase, 60-hertz, voltage, full load current.
  - 2. Engine: 4-cycle engine, fuel type, number of cylinders.
  - 3. Name and address of manufacturer.

### **2.06 FINISHES**

- A. Diesel engine-generator set equipment, weather-protective housing, sub-base fuel tank and fuel piping shall be primed for corrosion protection and coated in accordance with manufacturer's standard permanent coating system for outdoor installation.

## 2.07 CONTRACTOR SOURCE QUALITY TESTING

- A. Perform mechanical, electrical, and operational tests to confirm equipment meets specification requirements and applicable codes, standards, and regulations.
- B. Furnish test equipment and factory test technician.
- C. Perform testing in presence of COR.
- D. Notify COR at least 14-days in advance when tests are to be performed.
- E. Documentation:
  - 1. Date and sign.
  - 2. Identify specific feature being tested.
  - 3. Include test results and items such as: rated loads, power factor, ambient temperature, altitude, and fuel grade under which the test is performed.
  - 4. Submit as part of final data.
- F. Factory tests of the engine-generator set to include the following:
  - 1. Full load test: Conducted and documentation provided per NFPA 110.
  - 2. Cycle crank test: Conducted and documentation provided per NFPA 110.
  - 3. Vibration:
    - a. Loads: 50, 75, and 100 percent of nameplate rating.
    - b. At each of the loads, conduct vibration test and document engine-generator set vibration in mils (peak to peak).
    - c. Acceptable level of vibration: Vibration tolerance not greater than 5-mils (peak to peak), at full-rated operating speed, as measured in any direction (horizontal, vertical or axial) on main frame, engine, generator, and associated components.
    - d. If vibration exceeds this tolerance, properly balance and/or provide vibration isolators to reduce vibrations to an acceptable level prior to shipping.
- G. Test generator in accordance with NEMA MG-1. Demonstrate and document that electrical properties of generator excitation system, voltage regulation system, engine governor system, illuminated annunciators, and controls are acceptable for intended purpose and are in accordance with specification requirements.
- H. Adjust as required and retest until unit functions properly.
- I. Fuel tank factory test: Tested and repaired for leakage in accordance with requirements of UL 142.
- J. Correct defects demonstrated by above tests by and at the expense of Contractor to make equipment fully operational to satisfaction of COR.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install engine-generator set, fuel system, and weather-protective housings:
  - 1. In accordance with manufacturer's instructions and recommendations.
  - 2. As shown on drawing 1695-D-60491 and as directed by COR at Pumping Plant No. 4.
  - 3. As shown on drawing 1695-D-60492 and as directed by COR at Pumping Plant No. 7.
- B. Install non-shrink grout as shown on drawings 1695-D-60491 and 1695-D-60492.
- C. Install electrical equipment in accordance with NFPA 70.
- D. Expansion Anchors:
  - 1. Drill holes in concrete for installation of expansion anchors:
    - a. Drill holes straight and true to diameter and embedment depth as recommended by anchor manufacturer and in accordance with requirements of respective equipment manufacturers.
    - b. If embedded steel or reinforcement is encountered during drilling, use core drilling in accordance with expansion anchor manufacturer's recommendations.
  - 2. If drilling water is used, clean exposed concrete surfaces immediately after drilling to prevent discoloration.
- E. See Section 26 24 13 – Switchboards, DCA to coordinate automatic transfer switch installation with engine-generator set.
- F. After equipment is installed, testing completed, and adjustments made, repair any damage to coatings in accordance with engine-generator set manufacturer's recommended procedures. Repair any damage to satisfaction of COR.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Perform mechanical, electrical, and operational tests to confirm that equipment meets specification requirements and applicable codes, standards, and regulations:
  - 1. Furnish test equipment and commissioning personnel.
  - 2. Perform testing in presence of COR.
  - 3. Notify COR at least 14-days in advance when tests are to be performed.
  - 4. Conduct on-site testing of engine-generator set unit after complete installation of equipment.

5. Documentation:
  - a. Sign and date.
  - b. Identify specific feature being tested.
  - c. Include test results and items such as rated loads, power factor, ambient temperature, altitude, and fuel grade under which test is performed.
- B. On-site test:
  1. Conduct on-site test and document per NFPA 110.
  2. Coordinate testing with on-site testing of automatic transfer switch, see specification paragraph 26 24 13 – Switchboards, DCA.
  3. Correct defects disclosed by tests, or vibration which is detrimental to equipment, to satisfaction of COR.
  4. After completion of testing, check all fluids (including fuel) and refill as necessary. All fluids for testing supplied by Contractor.

### **3.03 TRAINING**

- A. Provide training at project site to instruct Government personnel in systems and operations of engine-generator set and fuel tank equipment.
- B. Use equipment service manuals and/or manufacturer approved materials for training.

**END OF SECTION**

**SECTION 26 41 13**  
**LIGHTNING PROTECTION FOR BUILDINGS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for items requiring grounding and bonding.

**1.02 REFERENCE STANDARDS**

- A. Institute of Electrical and Electronic Engineers (IEEE)
- B. National Fire Protection Association (NFPA)
1. NFPA 780-14 Standard for the Installation of Lightning Protection Systems
- C. Underwriters Laboratories, Inc. (UL)
1. UL 96-05 Standard for Lightning Protection Components

**1.03 SYSTEM DESCRIPTION**

- A. Provide a lightning protection system that meets the requirements of NFPA 780.
- B. Lightning protection system consists of air terminals, roof conductors, down conductors, and ground connections.
- C. Refer to Section 26 05 20 – Grounding and Bonding for Electrical Systems for grounding electrodes. Grounding system may require modifications to meet requirements of the lightning protection system.

**1.04 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 41 13-1, Qualifications.
- C. RSN 26 41 13-2, Approval Data:
1. Manufacturer's technical data.

- D. RSN 26 41 13-3, Approval Drawings:
1. Drawing showing the lightning protection system.
  2. Include plan and elevation views showing physical layout of equipment.
  3. Include mounting details and wiring diagrams showing interconnection between equipment.
  4. Modifications to the grounding system to meet requirements for lightening protection.
  5. Insulated roof panel certification.
- E. RSN 26 41 13-4, Test Plan:
1. See Contractor Field Quality Testing.
- F. RSN 26 41 13-5, Certificate:
1. See Contractor Field Quality Testing.

## **1.05 QUALIFICATIONS**

- A. Installer:
1. Certified with commercial third-party Inspection Company whose sole work is lightning protection, or is a UL Listed Lightning Protection Installer.
  2. Minimum of 2-years documented experience installing lightning protection systems.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. Do not use materials that accelerate corrosion in the presence of moisture.
- B. When metallic conduit is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic).
- C. Lightning protection components, such as bonding plates, air terminals, air terminal supports and braces, clips, connector fittings, and fasteners are to comply with requirements of UL 96 classes as applicable.

### **2.02 CONDUCTORS**

- A. NFPA 780 and UL 96; Class I.
- B. Main Conductors:
1. Stranded copper conductors: 57,400 circular mils at 187 pounds per 1,000-foot minimum.

- C. Secondary Conductors:
  - 1. Secondary or Bonding Conductors: 26,240 circular mils for copper minimum.

### **2.03 AIR TERMINALS**

- A. Provide solid air terminals with a blunt tip.
- B. Tubular air terminals are not permitted.
- C. Support air terminals more than 24-inches in length by suitable brace, supported at not less than one-half the height of the terminal.

### **2.04 CONNECTIONS AND TERMINATIONS**

- A. Provide connectors for splicing conductors that conform to UL 96, Class I.
- B. Conductor connections can be made by clamps or welds (including exothermic).
- C. Provide style and size connectors required for installation.

### **2.05 CONNECTOR FITTINGS**

- A. Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780 and UL 96.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install per NFPA 780.
- B. Expose conductors on the structures except where conductors are required to be in protective sleeves.
- C. Bond secondary conductors with grounded metallic parts within the building.
- D. Make interconnections within side-flash distances at or below the level of the grounded metallic parts.
- E. Coordinate with the roofing manufacturer and provide certification that the roof manufacturer's warranty is not violated by the installation methods for air terminals and roof conductors. See Section 07 41 13 – Preinsulated Metal Roof Panels.
- F. Use a standing seam base for installation of air terminals and roof conductors on a standing seam metal roof that does not produce any roof penetrations.
- G. Conceal roof conductors are within the ceiling cavities as much as practicable.

- H. Protect exposed down conductors from physical damage as required by NFPA 780.
- I. Use Schedule 80 PVC to protect down conductors. Paint the Schedule 80 PVC to match the surrounding surface with paint that is approved for use on PVC.
- J. Conceal down conductors within the wall cavities.
- K. Interconnection of grounding system to be below grade.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Provide a lightning protection and grounding system test plan.
- B. Detail both the visual inspection and electrical testing of the system and components in the test plan.
- C. Identify (number) the system test points/locations along with a listing or description of the item to be tested and the type of test to be conducted.
- D. As a minimum, include a sketch of the facility and surrounding lightning protection system as part of the specific test plan for each structure.
- E. Test the lightning protection and grounding system to ensure continuity is not in excess of 0.5-ohm.
- F. Provide documentation for measured values at each test point.
- G. Tie grounding system together and test for resistance to ground.
- H. Include in the written report:
  - 1. Locations of test points.
  - 2. Measured values for continuity and ground resistances.
  - 3. Soil conditions at the time that measurements were made.
- I. Submit results of each test.

### **3.03 CERTIFICATION**

- A. Provide signed certification from a commercial third-party inspection company, whose sole work is lightning protection. State that the lightning protection system complies with NFPA 780.
- B. Third party inspection Company cannot be system installer or system designer.
- C. Alternatively, provide UL Lightning Protection Inspection Master Label Certificate for each facility indicating compliance to NFPA 780.

**END OF SECTION**



2. Potential of structure in electrolyte as compared to potential of reference electrode making contact with same electrolyte.
3. Static structure-to-electrolyte potential: Structure-to-electrolyte potential determined without any external current (e.g. prior to energizing cathodic protection system, and with no galvanic couple, pH cell, interference currents, or the like present), or after such current source has been disconnected for an extended time. Also referred to as native structure-to-electrolyte potential.

#### **1.04 QUALIFICATIONS**

- A. Cathodic Protection Specialist: Certified by NACE International.

#### **1.05 QUALITY**

- A. Installation and testing conducted by or under direction of Cathodic Protection Specialist certified by NACE International. Other qualified individuals may assist installation and testing personnel.
- B. Manufacturer's Standards: Comply with manufacturer's recommendations and standards unless otherwise specified.
- C. NACE SP0169 and NACE TM0497 shall apply to any issues not specifically addressed by this specification.

#### **1.06 SYSTEM DESCRIPTION**

- A. Corrosion monitoring systems shall be provided for the following features:
  1. Pumping Plant No. 4 - Buried metallic pipe, fittings, and other associated metalwork.
  2. Pumping Plant No. 7 - Buried metallic pipe, fittings, and other associated metalwork.
- B. Corrosion-engineering services shall be provided to furnish, install, and test the corrosion monitoring system components:
  1. Include electrical continuity bonds, test stations, isolation joint flange kits, and accessory equipment and features as directed in this specification or as otherwise indicated.
  2. Designs, materials, installation and testing shall be consistent with sound corrosion engineering principles and practice in accordance with NACE SP0169, NACE TM0497, and Peabody.
- C. Corrosion monitoring systems will have capacity to:
  1. Provide a minimum service life of 20-years (system and all components).
- D. Electrical Continuity Bonds:

1. Metallurgical type bonds and shall assure electrical continuity of buried metalwork.
2. Bond cable designed such that their resistance does not detrimentally affect the performance of the cathodic protection system.

## **1.07 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 26 42 10-1, Certification and Data:
  1. Copy of Cathodic Protection Specialists' NACE International certification for personnel performing or directing installation and testing of corrosion monitoring system.
  2. Preconstruction drawings:
    - a. Intended location of test stations.
  3. Manufacturer's data including catalog data sheets when available, including (see Checklist at end of section):
    - a. Cables.
    - b. Metallurgical bonding system.
    - c. Dielectric coating system for bonds.
    - d. Test stations.
    - e. Isolation Joint Flange Kits (IJFK).
- C. RSN 26 42 10-2, Final Data:
  1. As-built information and drawings, including:
    - a. Locations of test stations, electrical continuity bonds, and cable runs.
      - 1) Locations shall be given using unique identifier and GPS coordinates
      - 2) Location shall include type of test station see drawing 1695-D-60646.
    - b. List of anode cable identifications in test stations.
  2. Testing data:
    - a. Test equipment and methods utilized.
    - b. Placement of reference electrode during each test.
    - c. Results of tests conducted.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. Installation details indicated on drawings 1695-D-60645 to 1695-D-60646.

### **2.02 CABLES**

- A. Conform to ASTM B3.
- B. Manufactured no more than 24-months prior to notice to proceed.
- C. Single-conductor: stranded, plain, annealed copper cable.
- D. Cable insulation:
1. Rated for 600-volts and direct immersion or burial.
  2. High molecular weight polyethylene (HMWPE) outer jacket with minimum thickness of 0.100-inch.
- E. Unspliced lengths to permit installation from terminus to terminus (e.g. structure to test station or structure to structure) free of splices and without stress.
- F. Gauge:
1. No. 2 AWG or larger for electrical continuity joint (jumper) bonds (black insulation).
  2. No. 12 AWG or larger structure cables for determining structure-to-electrolyte potentials (black insulation).

### **2.03 EXOTHERMIC METALLURGICAL BONDS**

- A. Exothermic metallurgical bond system by ThermOweld, 4102 South 74<sup>th</sup> East Ave., Tulsa, OK 74145; or equal, having the following essential characteristics:
1. Designed for:
    - a. Cathodic protection systems.
    - b. Metallic substrate material.
  2. Exothermic reaction produces molten copper, which produces permanent, high conductivity connection.
  3. Uses special alloy to provide minimum heat effect on substrate material.
  4. Current carrying capacity equal or better than that of the conductor.

## **2.04 TEST STATIONS**

- A. Test stations: TESTOX Series 100 or Series 700, manufactured by Gerome Electric Supply Co., 336 E. Main St., Uniontown, PA 15401; or equal, having the following essential characteristics:
1. Above-ground, cast aluminum, pipe-mounted type.
  2. Specifically constructed for cathodic protection system installations.
  3. Protected as required for permanency.
  4. Secured to pipe with setscrew or threaded.
  5. Sufficient number of terminals (5 terminals minimum) with associated hardware for number and size of cables and required accessories.
  6. Test station cables in accordance with cable requirements of this Section.

## **2.05 TEST STATION PIPE AND BOLLARDS**

- A. Steel Pipe:
1. In accordance with Section 05 50 00 – Metal Fabrications:
    - a. Pipe size indicated on drawing 1695-D-60646.
- B. Painting:
1. Test station support post coated or galvanized in accordance with Section 09 96 20 – Coatings.
  2. Protective post coated NTUA blue in accordance with Section 09 96 20 – Coatings.
- C. Concrete:
1. In accordance with applicable requirements of Section 03 30 00 – Cast-in-Place Concrete.

## **2.06 DIELECTRIC COATING FOR METALLURGICAL BONDS**

- A. Dielectric material: Royston Handy Cap, manufactured by Royston Laboratories, Inc., 128 First St., Pittsburgh, PA, 15238; or equal, having the following essential characteristics:
1. Specifically designed for cathodic protection systems.
  2. Applied with primer coat, as needed.
  3. Approved dielectric coating material.
  4. Suitable for the intended environment.

## **2.07 SAND BACKFILL**

- A. Sand Backfill: ASTM C33, fine aggregate.

## **2.08 ELECTRICAL CONTINUITY BOND CABLE CONDUIT**

- A. Schedule 80 PVC conduit and fittings for four (4) #2 AWG electrical continuity jumper bonds installed between buried metalwork upstream of pumping plant and buried metalwork downstream of pumping plant.

## **2.09 WARNING TAPE**

- A. Polyethylene warning tape for anode cables:
  1. Minimum 3-inches wide.
  2. Red or Yellow with Black lettering.
  3. Suitable for direct burial.
  4. "Caution –Cathodic Protection Cable Buried Below" printed on tape for its full length.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION OF CORROSION MONITORING SYSTEMS**

- A. Installation and testing shall be performed or directed by Cathodic Protection Specialist certified by NACE International.
- B. Installation details indicated on drawings 1695-D-60645 and 1695-D-60646.
- C. All structures to be electrically continuous for future cathodic protection shall be electrically isolated from other extraneous metal (e.g. casings, foreign structures, and rebar in concrete).
- D. Dielectric materials that might cause shielding of cathodic protection current (e.g. plastic debris) shall not be left in excavation with structure.
- E. Cable:
  1. Inspect for insulation defects prior to backfilling:
    - a. Replace cable if insulation is damaged.
  2. Install without kinks, stresses, and/or splices.
  3. Buried applications:
    - a. For all horizontal segments of cable (long segments of jumper bonds or test station cables) the following requirements must be met in accordance with drawing 1695-D-60645:

- 1) Minimum burial depth: 30-inches.
  - 2) Surround cable with minimum 6-inches of sand backfill.
  - 3) Place warning tape approximately 12-inches above cable for entire length of cable segments.
- b. Run cable through rigid galvanized conduit, test station pipe, or similar protection once cable emerges from ground.
4. Connect to test station terminals with crimped, ring-tongue connectors.
5. Identify origin of cables terminating in an enclosure:
  - a. Cable identification as to distinct originating structure or anode in accordance with drawing 1695-D-60646.
  - b. Printed letters on shrinkable label attached to cables clearly visible within enclosure.
  - c. Encase printed labels in clear heat shrink tubing.

F. Structure Cables:

1. Two cables per structure at each test station.
2. Connect cables to structures by exothermic metallurgical bond as shown in drawing 1695-D-60645:
  - a. Make exothermic metallurgical bond in accordance with bonding supply manufacturer's instructions.
  - b. Bonds shall not damage linings inside pipes or fittings.
  - c. Test metallurgical bond integrity by striking side of weld nugget with a 16-ounce hammer, in presence of COR.
  - d. Coat bare copper, weld nugget, and ferrous materials at metallurgical bonds with an approved dielectric metallurgical bond coating.
  - e. Allow dielectric material to cure before repair of damaged structure coating or lining:
    - 1) Repair dielectric coatings/linings in accordance with Section 09 96 20 – Coatings.

G. Electrical Continuity Joint (Jumper) Bonds:

1. Provide metallurgical bonds at mechanical type joints (e.g., non-welded joints) between ferrous parts included in a particular cathodic protection system as indicated in this section or as necessary to ensure electrical continuity.
2. Minimum of four cables per bond joint for metallic pipe sections:
  - a. Bond yard pipe in pumping plant to any existing line pipe on upstream and downstream of pumping plant.

- b. Install bond cables in buried PVC conduit to bond yard pipe upstream of the pumping plant to yard pipe downstream of the pumping plant
- 3. Bond cable installed with sufficient slack to prevent stress or tugging:
  - a. Allow for minimum 1/2-inch of joint movement.
- 4. Jumper Bond Locations:
  - a. Between non-welded ferrous pipe sections and ferrous pipe and fittings.

#### H. Test Stations:

- 1. Locations:
  - a. Specifically at the following locations:
    - 1) Corrosion monitoring test station on upstream and downstream line pipe at fence line.
    - 2) Isolation test stations at each IJFK.
  - b. Locate test stations to make them readily accessible.
  - c. Locate where test stations will not likely be damaged or interfere with personnel and/or equipment (e.g., adjacent to above ground structures). Exact location is subject to approval of COR.
  - d. Locate as close to structure connection as possible and convenient.
- 2. Details for test stations are shown in drawing 1695-D-60646.
- 3. Permanently, uniquely, and clearly identify each test station.
- 4. Terminate cables for given location within same test station enclosure. Identify cables as to distinct originating structure.
- 5. Test Stations should contain two cables, at a minimum:
  - a. No. 12 AWG test cables from structure for determining structure-to-soil potentials.

### 3.02 FIELD QUALITY TESTING

- A. Testing shall include testing corrosion monitoring systems.
- B. Testing shall be performed in presence of COR.
- C. Inform COR of date, time, and tests to be performed at least 5 working days prior to testing.
- D. Testing equipment:
  - 1. Portable Voltmeter: Minimum input impedance of 10-megohms and capable of measuring DC voltages between plus or minus 0.1-millivolt to plus or minus 100-volts.

2. Portable Cu/CuSO<sub>4</sub> reference electrode.
- E. Verify that each test station is properly labeled.
- F. Testing shall include the following:
1. Record and report all readings with final test data submittal.
  2. Native pipe-to-soil potentials at all test stations.
  3. Verify electrical continuity.
  4. Verify isolation at locations where IJFK's were installed.
- G. Troubleshoot and correct any problems determined by COR.
- H. Submit final data:
1. After reviewing submittal, Government may require additional testing and re-submittal to determine if corrosion monitoring system conforms to specification requirements.

**END OF SECTION**

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C. Cathodic Protection:

1. Sacrificial Protection: Reduction of corrosion of a metal in an electrolyte by electrically coupling it to a more anodic metal. This form of cathodic protection is also called galvanic anode cathodic protection.

D. Structure-to-Electrolyte Potential:

1. Also referred to as structure-to-water potentials.
2. Potential of structure in electrolyte as compared to potential of reference electrode making contact with the same electrolyte.
3. Static structure-to-electrolyte potential: Structure-to-electrolyte potential determined without any external current (e.g. prior to energizing cathodic protection system, and with no galvanic couple, pH cell, interference currents, or the like present), or after such current source has been disconnected for an extended time. Also referred to as native structure-to-electrolyte potential.
4. Uncorrected structure-to-electrolyte potential: Structure-to-electrolyte potential determined with cathodic protection system energized and cathodic protection current flowing. Potential is sometimes called protective potential and may contain significant IR drop error.
5. Polarized structure-to-electrolyte potential: Structure-to-electrolyte potential determined after cathodic protection system has been energized, but immediately after cathodic protection current is interrupted. Also referred to as “instant off” structure-to-electrolyte potential.
6. Polarization: Change from static or native potential as a result of current flow across electrode/electrolyte interface. Also considered difference between polarized and native potentials.

E. Bonded Dielectric Coating: Protective barrier coating system with high electrical resistivity bonded directly to underlying structure and acting to physically and electrically isolate metal from electrolyte.

F. Reference Electrode: Electrode with constant open circuit potential under similar conditions of measurement; used for measuring relative potentials of other electrodes (e.g. protected structures). Sometimes referred to as a reference half-cell. Copper/copper sulfate reference electrode (CSE) is often used.

## 1.04 QUALIFICATIONS

A. Cathodic Protection Specialist: Certified by NACE International.

## 1.05 QUALITY

A. Installation and testing conducted by or under the direction of a Cathodic Protection Specialist certified by NACE International. Other qualified individuals may assist installation and testing personnel.

- B. Manufacturer's Standards: Comply with manufacturer's recommendations and standards unless otherwise specified
- C. NACE SP0169, NACE SP0196, and NACE TM0497 shall apply to any issues not specifically addressed by this specification section.

## **1.06 SYSTEM DESCRIPTION**

- A. Cathodic protection and corrosion monitoring systems shall be provided for the following features:
  - 1. Pumping Plant No. 4 - Above-ground steel tank (Quantity 1).
  - 2. Pumping Plant No. 4 - Air Chambers (Quantity 4).
  - 3. Pumping Plant No. 7 - Above-ground steel tank (Quantity 1).
  - 4. Pumping Plant No. 7 - Air Chambers (Quantity 4).
- B. Corrosion-engineering services shall be provided to furnish, install, and test galvanic anode cathodic protection system:
  - 1. Include anodes, and accessory equipment and features as directed in this specification section or as otherwise indicated.
  - 2. Designs, materials, installation and testing in accordance with NACE SP0169, NACE SP0196, NACE TM0497, and Peabody.
- C. Cathodic protection systems shall have capacity to:
  - 1. Provide a minimum service life of 20-years (system and components).
  - 2. Maintain on all locations of protected structures, with reference to a copper/copper sulfate electrode placed close to structure:
    - a. Polarized structure-to-electrolyte potential of -0.850 volts or more negative on the structure having high quality bonded dielectric coating.
    - b. Alternately, at discretion of Reclamation, -0.100 volts of polarization if -0.850 volt criterion cannot be obtained due to extenuating circumstances (e.g. on bare or poorly coated structures).
    - c. Polarized potential at any point on a dielectrically coated structure not more negative than -1.100 volts.
- D. Placement and current output of anodes:
  - 1. Provide adequate distribution of cathodic protection current, as indicated by polarized potential readings.
  - 2. Submerged and restrained in such way as to:
    - a. Maintain sufficient anode material below minimum normal operating water level.

- b. Not place stress on anode cables, which will be suitable for direct immersion.

## 1.07 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 26 42 11-1, Certification and Data:
  - 1. Copy of Cathodic Protection Specialists' NACE International certification for personnel performing or directing installation and testing of cathodic protection systems.
  - 2. Preconstruction drawings detailing intended restraint of anodes.
  - 3. Manufacturer's data including catalog data sheets when available, including:
    - a. Galvanic anodes.
    - b. Cables.
    - c. Metallurgical bonding system.
    - d. Dielectric coating system for bonds.
    - e. Dielectric anode covering at anode hold points.
    - f. Anode junction box.
    - g. Galvanic anode cathodic protection controller.
    - h. Coated wire rope.
    - i. Cable conduit.
    - j. Permanent reference electrodes.
- C. RSN 26 42 11-2, Final Data:
  - 1. As-built information and drawings, including:
    - a. Locations of anodes and restraints.
    - b. List of cable identifications in junction box and controller.
  - 2. Test Data:
    - a. Test equipment and methods utilized.
    - b. Placement of reference electrode during each test.
    - c. Results of tests conducted.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. Installation details indicated on drawings 1695-D-60640 to 1695-D-60644 and 1695-D-60647 to 1695-D-60648.

### **2.02 CABLES**

- A. Conform to ASTM B3.
- B. Manufactured no more than 24-months prior to Notice to Proceed.
- C. Single-conductor: Stranded, plain, annealed copper cable.
- D. Cable insulation:
  - 1. Rated for 600-volts and direct immersion.
  - 2. Black, with high molecular weight polyethylene (HMWPE) outer jacket with minimum thickness of 0.100 inch.
- E. Unspliced lengths to permit installation from terminus to terminus (e.g. anode to junction box) free of splices and without stress, unless otherwise required by specification section.
- F. Gauge:
  - 1. No. 12 AWG or larger for structure cable (black insulation).
  - 2. No. 12 AWG or larger for galvanic anodes (black insulation).
  - 3. No. 14 AWG or larger for permanent reference electrodes (yellow insulation).

### **2.03 EXOTHERMIC METALLURGICAL BONDS**

- A. Exothermic metallurgical bond system by ThermOweld, 4102 South 74<sup>th</sup> East Ave., Tulsa, OK 74145; or equal, having the following essential characteristics:
  - 1. Designed for:
    - a. Cathodic protection systems.
    - b. Metallic substrate material.
    - c. Bond orientation.
  - 2. Exothermic reaction produces molten copper, which produces permanent, high conductivity connection.
  - 3. Uses special alloy to provide minimum heat effect on substrate material.
  - 4. Current carrying capacity equal or better than that of conductor.

## **2.04 GALVANIC ANODES**

- A. Extruded rod UltraMag high potential magnesium anode, manufactured by Farwest Corrosion Control Company, 12029 Regentview Avenue, CA 90241; or equal, with the following essential characteristics:
1. High potential magnesium anode material specifically designed for cathodic protection systems and intended environment.
  2. Magnesium rod anode material length and diameter specified for Pumping Plant No. 4 and Pumping Plant No. 7 welded above-ground storage tanks on drawings 1695-D-60640 to 1695-D-60644 and 1695-D-60647 to 1695-D60648.
  3. Anode material meeting or exceeding requirements of ASTM B843 and having a minimum potential of -1.7 volts referenced to copper/copper sulfate reference electrode (CSE).
  4. Contain mild steel core that extends essentially entire length of anode. Mild steel core shall be centered within anode material and exposed on one end of anode for factory made anode-to-cable connection.
- B. Extruded rod ProMag standard potential magnesium anode, manufactured by Farwest Corrosion Control Company, 12029 Regentview Avenue, CA 90241; or equal, with the following essential characteristics:
1. Standard potential magnesium anode material specifically designed for cathodic protection systems and intended environment.
  2. Magnesium rod anode material length and diameter specified for Pumping Plant No. 4 and Pumping Plant No. 7 air chambers on drawings 1695-D-60647 and 1695-D-60648 respectively.
  3. Anode material meeting or exceeding requirements of ASTM B843 and having a minimum potential of -1.5 volts referenced to copper/copper sulfate reference electrode (CSE).
  4. Contain mild steel core that extends essentially entire length of anode. Mild steel core shall be centered within anode material and exposed on one end of anode for factory made anode-to-cable connection.
- C. Factory anode-to-cable connection, exposed mild steel core, and exposed copper cable potted in epoxy.
- D. Silver-solder connection between anode cable and mild steel core.
- E. Anode cable in accordance with cable requirements of this section.

## **2.05 DIELECTRIC COATING FOR METALLURGICAL BONDS**

- A. Coat exposed weld nugget, exposed cable, or structure metal using Bitumastic 50 (Carboline) or equal.

- B. Refer to Section 09 96 20 – Coatings.

## **2.06 ANODE JUNCTION BOX**

- A. Enclosed within a NEMA 250, Type 3-R, lockable cabinet constructed of No. 16-gauge or thicker galvanized steel or fiberglass that is weatherproof, lockable, and vented for heat dissipation.
- B. Specifically constructed for cathodic protection system installations.
- C. Protected as required for permanency.
- D. Sufficient number of terminals (5 terminals minimum) with associated hardware for number and size of cables.
- E. Engraved 1/4-inch minimum NEMA grade C phenolic panel.
- F. Solderless, pressure-type terminals.
- G. Identified terminals.
- H. Equip with combination bracket for pole or wall mounting.

## **2.07 AUTO-POTENTIAL MAGNESIUM ANODE CONTROLLER FOR ABOVE-GROUND STORAGE TANKS**

- A. PowerMag 1000 auto-potential magnesium anode controller, manufactured by Farwest Corrosion Control Company, 12029 Regentview Avenue, CA 90241; or equal, with the following essential characteristics:
  - 1. Automatic potential control set range, adjustable from -0.7 to -1.5 V.
  - 2. IR-Free cathodic protection readings.
  - 3. Uses sacrificial magnesium anodes for power.
  - 4. No external power required.
  - 5. NEMA 4X, non-metallic enclosure.

## **2.08 ELECTRICAL CONDUIT**

- A. Galvanized steel conduit for anodes and permanent reference electrode cables.

## **2.09 PERMANENT REFERENCE ELECTRODE**

- A. Copper/Copper Sulfate permanent reference electrode for use in fresh water service: STAPERM Model CU-2-FW, manufactured by GMC Electrical, Incorporated, 2027 E., Ontario CA 91761; or equal, having the following characteristics:
  - 1. Rugged 1-inch plastic housing.

2. Plus or minus 5 mV with 3.0 micro-amp load.
3. Minimum 20-year design life.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION OF GALVANIC ANODE CATHODIC PROTECTION SYSTEMS**

#### **A. Cable:**

1. Inspect for insulation defects prior to after installation:
  - a. Cables shall be replaced if insulation is damaged.
  - b. COR shall approve and inspect necessary splices prior to installation.
2. Install without kinks and/or stresses.
3. Run cable through rigid galvanized conduit or similar protection once cable emerges from tank interior.
4. Protect cables inside tanks from damage and stresses.
5. Connect to junction box terminals with crimped, ring-tongue connectors.
6. Identify origin of cables terminating in an enclosure:
  - a. Cable identification as to the distinct anode in accordance with drawing 1695-D-60645.

#### **B. Above-Ground Storage Tank:**

1. Install anodes vertically in Pumping Plant #4 and Pumping Plant #7 above-ground storage tanks as described in drawings 1695-D-60640 to 1695-D-60643.
2. Anode Cables:
  - a. Do not support array anodes by their cables. Use coated stainless steel wire ropes as described in drawings.
  - b. Run anode cables to roof of tanks and out single port to junction box and auto-potential controller.
  - c. Run cables through a galvanized conduit outside of tank to junction box and auto-potential controller.
  - d. Protect cables from damage inside tanks.
  - e. Do not connect anodes to structures at junction boxes or auto-potential controller; energizing systems only at time of testing.
3. Permanent Copper/Copper Sulfate Reference Electrodes:
  - a. Install three permanent reference electrodes in each tank:
    - 1) Install two reference electrodes on tank walls placed on opposite sides of tank:

- a) Install on bottom anode-to-tank wall support rope with dielectric tape and non-metallic cable ties.
    - 2) Install one reference electrodes on tank floor near the center of the tank:
      - a) Install on tank floor on coated bracket with dielectric tape and non-metallic cable ties.
    - b. Protect reference electrode cables from damage inside tanks.
    - c. Run reference electrode cables to roof of tanks and out single port with anode cables to junction box and auto-potential controller.
  4. Junction Boxes and Auto-Potential Controllers:
    - a. Location:
      - 1) Against or mounted to outside tank wall.
      - 2) Minimum 4-feet from ground level.
- C. Air Chambers:
1. Install anodes vertically in a box configuration for Pumping Plant No. 4 and Pumping Plant No. 7 air chambers as described in drawings 1695-D-60647 and 1695-D-60648.
  2. Anode Cables:
    - a. Do not support array anodes by their cables. Use coated stainless steel wire ropes as described in drawings.
    - b. Connect anode cables directly to tank walls above the max water elevation by exothermic metallurgical bond as shown on drawing 1695-D-60645:
      - 1) Make exothermic metallurgical bond in accordance with bonding supply manufacturer's instructions.
      - 2) Bonds shall not damage external coatings on tanks; otherwise, repairs shall be required.
      - 3) Test metallurgical bond integrity by striking side of weld nugget with a 16-ounce hammer, in presence of COR.
      - 4) Coat bare copper, weld nugget, and ferrous materials at metallurgical bonds with an approved dielectric metallurgical bond coating.
      - 5) Allow dielectric material to cure before repair of damaged structure coating or lining:
        - a) Repair dielectric coatings/linings in accordance with Section 09 96 20 – Coatings.

### 3.02 CONTRACTOR FIELD QUALITY TESTING

- A. Include energizing, adjusting, and testing cathodic protection systems for above-ground storage tanks.
- B. Performed in presence of COR.
- C. Inform COR of date, time, and tests to be performed at least 5 working days prior to testing.
- D. Testing Equipment:
  - 1. Portable Voltmeter: Minimum input impedance of 10-megohms and capable of measuring DC voltages between plus or minus 0.1 millivolt to plus or minus 100-volts.
  - 2. Portable Cu/CuSO<sub>4</sub> reference electrode.
- E. Record and report readings with final test data submittal.
- F. Testing shall be conducted at least in 2 testing cycles:
  - 1. First Testing Cycle:
    - a. Prior to energizing the system:
      - 1) Junction box and auto-potential controller integrity:
        - a) Determine voltage difference between structure cables.
      - 2) Measure potential difference between permanent copper/copper sulfate reference electrodes and portable copper/copper sulfate reference electrode:
        - a) Potential: 0.00 plus or minus 10 mV.
      - 3) Measure potential difference between permanent copper/copper sulfate reference electrodes in each tank:
        - a) Potential: 0.00 plus or minus 5 mV.
      - 4) Measure static structure-to-water potentials with each permanent reference electrode.
    - b. After energizing the system:
      - 1) Determination of protective (uncorrected) and polarized structure-to-water potentials in accordance with capacity requirements of this Section:
        - a) Measure potentials with each permanent reference electrode.
      - 2) Adjust auto-potential controller if necessary.

2. Second and Subsequent Testing Cycles:
  - a. Time between testing cycles shall be 30- to 60-days.
  - b. Cathodic protection system shall not be adjusted between testing cycles.
  - c. Repeat testing required after energizing the system during the first testing cycle.
  - d. If testing cycle data indicates cathodic protection system requires adjustment to meet requirements, adjust cathodic protection system and conduct subsequent testing cycles within 30- to 60-days.
- G. Troubleshoot and correct any problems determined by COR.
- H. Submit final data after last testing cycle when performance criteria have been met and no further adjustments are needed.
- I. After reviewing submittal, Government may require additional testing cycles, adjustments, and re-submittal to determine if cathodic protection system conforms to requirements.

**END OF SECTION**

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3. Static structure-to-electrolyte potential: Structure-to-electrolyte potential determined without external current (e.g. prior to energizing a cathodic protection system, and with no galvanic couple, pH cell, interference currents, or the like present), or after such a current source has been disconnected for an extended time. Also referred to as native structure-to-electrolyte potential.
  4. Uncorrected structure-to-electrolyte potential: The structure-to-electrolyte potential determined with the cathodic protection system energized and cathodic protection current flowing. This potential is sometimes called the protective potential and may contain significant IR drop error.
  5. Polarized structure-to-electrolyte potential: The structure-to-electrolyte potential determined after the cathodic protection system has been energized, but immediately after the cathodic protection current is interrupted. Also referred to as “instant off” structure-to-electrolyte potential.
  6. Polarization: Change from the static or native potential as a result of current flow across the electrode/electrolyte interface. Also considered the difference between polarized and native potentials.
- C. Structure: Submerged surface of a steel tank or other metalwork being protected and monitored.
- D. Electrolyte: An electrically conductive solution, such as soil or water. The terms for these specific conductive solutions may be substituted for the word “electrolyte” in these definitions.
- E. Bonded Dielectric Coating: A protective barrier coating system with high electrical resistivity bonded directly to the underlying structure and acting to physically and electrically isolate the metal from the electrolyte.
- F. Cable: Metallic conductors other than the protected structures and the anodes.
- G. Portable Voltmeter: Any portable instrument for measuring voltage drops across electrical components or potential (voltage) differences between a structure and a stable reference electrode:
1. Should have a minimum input impedance of 10-megohm.
  2. Should be capable of measuring DC voltages between plus or minus 0.1 volts and plus or minus 100-volts.
  3. When measuring structure potentials using a digital instrument, connect the positive terminal of the voltmeter to the structure and the common (negative) terminal to the reference electrode. Read the magnitude and polarity of the voltage directly as shown on the instrument display.
  4. When measuring structure potentials using an analog instrument with a needle that swings only in one direction, reverse connections and interpretation of the polarity by the user is required.

- H. Reference Electrode: An electrode whose open circuit potential is constant under similar conditions of measurement; used for measuring the relative potentials of other electrodes (e.g. protected structures). Sometimes referred to as a reference half-cell. A copper/copper sulfate reference electrode (CSE) is often used.

#### **1.04 QUALIFICATIONS**

- A. Design, installation, and testing shall be directed or performed by a Cathodic Protection Specialist certified by NACE International. Other qualified individuals may assist testing personnel.
- B. Manufacturer's Standards: Comply with manufacturer's recommendations and standards unless otherwise specified.
- C. NACE SP0169, NACE SP0196, and NACE TM0497 shall apply to issues not addressed by this section.

#### **1.05 SYSTEM DESCRIPTION**

- A. Provide cathodic protection and corrosion monitoring systems for:
1. Above-ground steel tank.
- B. Provide corrosion-engineering services to design, furnish, install, and test galvanic anode cathodic protection system:
1. Include anodes and accessory equipment and features as directed in this section or as otherwise indicated.
  2. Designs, materials, installation and testing in accordance with NACE SP0169, NACE SP0196, NACE TM0497, and Peabody.
- C. Cathodic protection systems:
1. Minimum service life of 20-years for system and components.
  2. Maintain on locations of protected structure(s), with reference to a copper/copper sulfate electrode placed close to the structure:
    - a. A polarized structure-to-electrolyte potential of at least minus 0.850-volts on the structure having a high quality bonded dielectric coating.
    - b. Alternately, at discretion of Reclamation, minus 0.100-volts of polarization if minus 0.850-volt criterion cannot be obtained.
    - c. A polarized potential at any point on a dielectrically coated structure not exceeding minus 1.100-volts in all instances.
- D. Placement of anodes:
1. Provide adequate distribution of cathodic protection current.

2. Submerged:
  - a. Maintain sufficient anode material below minimum normal operating water level.
  - b. Not place stress on anode cables, which will be suitable for direct immersion.

## **1.06 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 26 42 12-1, Certification, Design, and Manufacturer's Data:
  1. Copy of Cathodic Protection Specialists' NACE International certification for personnel performing or directing design, installation, and testing of corrosion monitoring system.
  2. Cathodic Protection System Design including:
    - a. Design calculations.
    - b. Preconstruction drawings detailing anode placement and electrical connections.
  3. Manufacturer's data including catalog data sheets when available, including:
    - a. Galvanic anodes.
    - b. Cables.
    - c. Metallurgical bonding system.
    - d. Dielectric coating system for bonds.
    - e. Associated installation materials.
- C. RSN 26 42 12-2, Final Data:
  1. As-built information and drawings, including:
    - a. Locations of anodes.
  2. Testing data:
    - a. Test equipment and methods utilized.
    - b. Placement of reference electrode during each test.
    - c. Results of tests conducted.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. Minimum cathodic protection service life: 20-years for system and components.

## **2.02 CABLES**

- A. Manufactured no more than 24-months prior to Notice to Proceed.
- B. Cathodic Protection:
  - 1. Single-conductor: Stranded, plain, annealed copper cable.
  - 2. Cable insulation:
    - a. Rated for 600-volts and direct immersion.
    - b. Black, with a high molecular weight polyethylene (HMWPE) outer jacket with minimum thickness of 0.100-inch.
  - 3. Unspliced lengths to permit installation from terminus to terminus free of splices and without stress.
- C. Gauge:
  - 1. No. 12 AWG or larger for galvanic anodes (red insulation if available).

## **2.03 EXOTHERMIC METALLURGICAL BONDS**

- A. Designed for cathodic protection systems and for metallic substrate materials.
- B. Exothermic reaction which produces a permanent, high conductivity connection.
- C. Uses a special alloy to provide minimum heat effect on substrate material.
- D. Current carrying capacity equal or better than that of the conductor.

## **2.04 DIELECTRIC COATING FOR METALLURGICAL BONDS**

- A. Coat exposed weld nugget, exposed cable, or structure metal using Bitumastic 50 (Carboline) or equal.
- B. Refer to Section 09 96 20 – Coatings.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION OF GALVANIC ANODE CATHODIC PROTECTION SYSTEMS**

- A. Installation and testing shall be performed or directed by a Cathodic Protection Specialist certified by NACE International.
- B. Cable:
  - 1. Inspect for insulation defects prior to backfilling:
    - a. Cables shall be replaced if insulation is damaged.

2. Install without kinks, stresses, and/or splices.
  3. Protect cables inside tanks from damage and stresses.
- C. Make exothermic metallurgical bond in accordance with bonding supply manufacturer's instructions:
- a. Bonds shall not damage linings inside tank.
  - b. Test metallurgical bond integrity by striking side of weld nugget with a 16-ounce hammer, in presence of COR.
  - c. Coat bare copper, weld nugget, and ferrous materials at metallurgical bonds with an approved dielectric metallurgical bond coating:
    - 1) Allow dielectric material to cure before repair of damaged structure coating or lining:
      - a) Repair dielectric coatings/linings in accordance with Section 09 96 20 – Coatings.
- D. Galvanic Anodes:
1. Located such as to provide adequate potential distribution to tank surface to meet polarization criteria requirements.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Include energizing, adjusting, and testing cathodic protection systems.
- B. Performed in the presence of COR.
- C. Inform COR of date, time, and tests to be performed at least 5 working days prior to testing.
- D. Testing equipment:
1. Portable Voltmeter: Minimum input impedance of 10-megohms and capable of measuring DC voltages between plus or minus 0.1-millivolt to plus or minus 100-volts.
  2. Portable Cu/CuSO<sub>4</sub> reference electrode.
  3. Temporary test coupons placed at various locations inside the tank if anodes connected directly to structure (dependent on accessibility).
- E. Record and report readings with final test data submittal.
- F. Testing shall be conducted in least 2 testing cycles utilizing temporary test coupons:
1. First testing cycle:
    - a. Prior to energizing the system:

- 1) Measure static structure-to-water potentials:
    - a) Place portable reference electrode as close to submerged surface or coupons as possible for structure-to-water potential measurements.
    - b) Measure at following locations on the tank surface or test coupons (dependent on accessibility):
      - i. Bottom.
      - ii. Middle.
      - iii. Just below surface level.
      - iv. Various locations around tank.
      - v. Bottom center.
  - b. After energizing the system:
    - 1) Determination of protective (uncorrected) and polarized structure-to-water potentials in accordance with capacity requirements of this Section.
      - a) Place portable reference electrode as close to the submerged surface or coupons as possible for structure-to-water potential measurements.
      - b) Measure at following locations on the tank surface or coupons (dependent on accessibility):
        - i. Bottom.
        - ii. Middle.
        - iii. Just below surface level.
        - iv. Various locations around tank.
        - v. Bottom center.
  2. Second and subsequent testing cycles:
    - a. Time between testing cycles shall be 30- to 60-days.
    - b. Cathodic protection system shall not be adjusted between testing cycles.
    - c. Repeat testing required after energizing the system during the first testing cycle.
    - d. If testing cycle data indicates cathodic protection system requires adjustment to meet requirements, adjust cathodic protection system and conduct subsequent testing cycles within 30- to 60-days.
- G. Submit final data after last testing cycle when performance criteria have been met and no further adjustments are needed.

- H. After reviewing submittal, Government may require additional testing cycles, adjustments, and re-submittal to determine if cathodic protection system conforms to requirements.

**END OF SECTION**

**SECTION 26 51 00**  
**INTERIOR LIGHTING**

**1.01 MEASUREMENT AND PAYMENT**

- A. Interior Lighting:
1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 SUBMITTALS**

- A. Submit in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 51 00-1, Approval Data:
1. Manufacturer's data.
- C. RSN 26 51 00-2, As-built Drawings:
1. As-built conditions of all interior lighting drawings.

**PART 2 PRODUCTS**

**2.01 GENERAL**

- A. Luminaires: Underwriters Laboratories Inc. (UL) listed.
- B. Provide all necessary mounting hardware.

**2.02 TYPE A LUMINAIRE**

- A. I-Beam LED High Bay manufactured by Lithonia Lighting, [www.lithonia.com](http://www.lithonia.com), Catalog # IBL\_12L\_WD\_LP840; or equal, having the following essential characteristics:
1. Lamp Type: LED.
  2. Color Temperature: 4,000 kelvin (K).
  3. Color Rendering Index (CRI): 80 minimum.
  4. Voltage:
    - a. Pump Room 277-volts.
    - b. Chemical Building 120 volts
  5. Length: 45 1/8-inches, Width: 15 7/8-inches.
  6. Mounting: Surface or short suspension mounting from roofing structure.
  7. Internal Wiring: Thermally protected to meet temperature requirements of fixture.

8. Internal Access: Tool-less entry from below fixture.
9. UL listed for ambient operations up to 55 degrees C and damp locations.
10. Warranty: 5-year, minimum.

### **2.03 TYPE B LUMINAIRE**

- A. HBX LED High Bay manufactured by Philips Day-Brite - Philips CFI, [www.usa.lighting.philips.com](http://www.usa.lighting.philips.com), Catalog # HBX13LL40-UNV-M-WT; or equal, having following essential characteristics:
1. Lamp Type: LED.
  2. Color Temperature: 4,000 kelvin (K).
  3. Color Rendering Index (CRI): 80 minimum.
  4. Voltage: 277-volts.
  5. Length: 23 5/8-inches, Width: 17 3/4-inches.
  6. Mounting: Surface or short suspension mounting from roofing structure.
  7. Internal Wiring: Thermally protected to meet temperature requirements of fixture
  8. Finish: White.
  9. Warranty: 5-year, minimum.

### **2.04 TYPE C LUMINAIRE**

- A. Square-basket LED Wraparound SBL4 manufactured by Lithonia Lighting, [www.lithonia.com](http://www.lithonia.com), Catalog # SBL4-3000LM-80CRI-40K-NODIM-MVOLT; or equal, having following essential characteristics:
1. Lamp Type: LED.
  2. Color Temperature: 4,000 kelvin (K).
  3. Color Rendering Index (CRI): 80 minimum.
  4. Voltage (Pumping Plant): 277-volts.
  5. Voltage (Chemical Building): 120-volts.
  6. Length: 48-inches, Width: 8 5/8-inches.
  7. Mounting: Surface or short suspension mounting from roofing structure
  8. Finish: White.
  9. Warranty: 5-year, minimum.

### **2.05 TYPE D LUMINAIRE**

- A. UFIT LED Low Bay manufactured by Lithonia Lighting, [www.lithonia.com](http://www.lithonia.com), Catalog # UFIT L48 4000LM SEF MVOLT EZ1 40K 80CRI WH; or equal, having the following essential characteristics:

1. Lamp Type: LED.
2. Color Temperature: 4,000 kelvin (K).
3. Color Rendering Index (CRI): 80 minimum.
4. Voltage: 120 volts
5. Length: 48.2-inches, Width: 9.8-inches.
6. Mounting: Surface or short suspension mounting from roofing structure.
7. Internal Wiring: Thermally protected to meet temperature requirements of fixture.
8. Lumen Output: Up to 2500 lumens per foot.
9. UL listed for ambient operations up to 40 degrees C and damp locations.
10. Warranty: 5-year, minimum.

## **2.06 FABRICATION**

- A. Luminaires requiring special modifications shall be modified and wired by manufacturer.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install luminaires and accessories as indicated and in accordance with manufacturer's instructions.
- B. Install specified lamps in luminaires.
- C. Aim and adjust luminaires as indicated.
- D. Install fittings and accessories required for complete installation.
- E. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- F. Make connections to branch circuits. Use insulated conductors with insulation suitable for temperature conditions within luminaire.
- G. Bond luminaires to branch circuit equipment grounding conductor.
- H. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- I. Remove dirt and debris from enclosures.
- J. Clean photometric control surfaces as recommended by manufacturer.

- K. Clean finishes and touch up damage.
- L. Clean luminaires and install new lamps for broken or burned out lamps.

**END OF SECTION**

**SECTION 26 52 00**  
**EMERGENCY AND EXIT LIGHTING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Emergency and Exit Lighting:
1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

- A. National Fire Protection Association (NFPA)
1. NFPA 70-2017 National Electrical Code (NEC)
  2. NFPA 101-2015 Life Safety Code
- B. Underwriters Laboratories (UL)
1. UL 924-2016 Standard for Emergency Lighting and Power Equipment

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 52 00-1, Approval Data:
1. Manufacturer's data.
- C. RSN 26 52 00-2, As-built Drawings:
1. As-built conditions of all emergency and exit lighting drawings.

**PART 2 PRODUCTS**

**2.01 GENERAL**

- A. Luminaires: Underwriters Laboratories Inc. (UL) listed.
- B. Provide all necessary mounting hardware.
- C. Luminaires requiring special modifications shall be modified and wired by manufacturer.

## 2.02 TYPE E1 LUMINAIRE

A. REL LED Series Emergency Lighting Units manufactured by Cooper Lighting, [www.cooperlighting.com](http://www.cooperlighting.com), Catalog #10-REL36-LED42; or equal, having following essential characteristics:

1. Self-contained emergency lighting unit with adjustable lamps.
2. Two, high efficiency LED heads.
3. Housing: Die-formed steel with white corrosion-resistant polyester powder coat paint.
4. 120/277-volt AC input.
5. Solid state battery charger. UL 924 listed.
6. Low voltage disconnect (80-percent of battery nominal), brownout protection, and short-circuit protection.
7. Solid-state transfer for switching on/off the AC circuit during outages.
8. Test switch and power indicator light for maintenance purposes.
9. Maintenance free, sealed nickel cadmium battery rated for 90-minute minimum.
10. Operating temperature range 0 to 50 degrees C.
11. Warranty: 1-year for unit and 15-years prorated for battery.

## 2.03 TYPE E2 LUMINAIRE

A. Quantum Exit Sign by Lithonia Lighting, [www.lithonia.com](http://www.lithonia.com), Catalog # LQC-X-R-ELN; or equal, having the following essential characteristics:

1. Light Emitting Diode (LED) exit sign.
2. Red LED illumination.
3. Single or double face as indicated.
4. Chevrons as indicated.
5. Wall mounted on end or back as indicated.
6. 120/277-volt AC selectable input.
7. Solid-state voltage charger.
8. Test switch/power indicator light.
9. Maintenance free, sealed nickel cadmium battery rated for 90-minute minimum.
10. 6-inch letters. Meets UL 924 for viewing distance.
11. Housing: Die-cast aluminum, brushed aluminum faceplate.
12. Warranty: 5-year, minimum.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install as indicated and in accordance with manufacturer's instructions, NFPA 70, and NFPA 101.
- B. Aim and adjust emergency lighting units per applicable codes.
- C. Install fittings and accessories required for complete installation.
- D. Install surface mounted emergency lighting units and exit signs plumb and adjust to align with building lines and each other. Secure to prevent movement.
- E. Make connections to branch circuits as indicated on the drawings. Use insulated conductors with insulation suitable for temperature conditions within emergency lighting units.
- F. Operate each emergency lighting unit and exit sign after installation and connection. Inspect for proper connection and operation.
- G. Remove dirt and debris from enclosures.
- H. Clean finishes and touch up damage to match surrounding finish.
- I. Clean emergency lighting units and exit signs and install new lamps for broken or burned out lamps.

**END OF SECTION**

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**SECTION 26 56 00**  
**EXTERIOR LIGHTING**

**1.01 MEASUREMENT AND PAYMENT**

- A. Exterior Lighting:
1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 SUBMITTALS**

- A. Submit in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 26 56 00-1, Approval Data:
1. Manufacturer's data.
- C. RSN 26 56 00-2, As-built Drawings:
1. As-built conditions of all exterior lighting drawings.

**PART 2 PRODUCTS**

**2.01 GENERAL**

- A. Luminaires: Underwriters Laboratories Inc. (UL) listed.
- B. Provide all necessary mounting hardware.
- C. Luminaires requiring special modifications shall be modified and wired by manufacturer.

**2.02 TYPE AA LUMINAIRE**

- A. Edge LED Security Wall Pack manufactured by Cree, [www.cree.com/lighting](http://www.cree.com/lighting) Catalog # SEC-EDG-4MB-WM-04-E-UL-BZ-350-40K; or equal, having the following essential characteristics:
1. Light Emitting Diode (LED) luminaire.
  2. L70 value of 150,000 hours minimum.
  3. Color temperature: LED 4,000 kelvin (K).
  4. LEDs per luminaire: As shown.
  5. 350mA drive current.
  6. 120 or 277 volts as indicated
  7. BUG rating of 1, 0, 1 respectively.
  8. Finish: Bronze.

9. International Dark Sky Association Compliance.
10. Die-cast extruded aluminum housing.
11. Resistant finish preventing corrosion, ultraviolet, and abrasion.
12. Wall mounted.
13. UL Wet listed.
14. Operating temperature range: -40 to 40 degrees C.
15. Warranty: 5-year, minimum.

### **2.03 TYPE BB LUMINAIRE**

- A. 303-W1-LEDB1 EON LED manufactured by Cooper Lighting, <http://www.cooperindustries.com> Catalog # 303-W1-LEDB1-4000-UNV-T2; or equal, having the following essential characteristics:
1. Light Emitting Diode (LED) luminaire.
  2. TM-21 reported L70(10k) >60,000 hours minimum.
  3. Color temperature: LED 4,000 kelvin (K).
  4. Voltage: 120 Volts.
  5. Finish: Bronze.
  6. Machined corrosion resistant 6061-T6 aluminum.
  7. Resistant finish preventing corrosion, ultraviolet, and abrasion.
  8. Wall mounted.
  9. UL Wet listed.
  10. Operating temperature range: -40 to 50 degrees C.
  11. Warranty: 5-year, minimum.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install luminaries as indicated on drawings and in accordance with manufacturer's instructions.
- B. Install fittings and accessories required for complete installation.
- C. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- D. Remove dirt and debris from enclosures.
- E. Clean photometric control surfaces as recommended by manufacturer.

- F. Clean finishes and touch up damage to match surrounding finish.
- G. Clean luminaires and install new lamps for broken or burned out lamps.
- H. Control exterior luminaires by lighting control panel listed in Section 26 24 41 – Distribution Panelboards.

**END OF SECTION**

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**SECTION 27 30 01**  
**TELEPHONE SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Telephone System:
1. Payment: Lump sum price offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

- A. Institute of Electrical and Electronic Engineers (IEEE)
1. IEEE 802.3-2015 Standard for Ethernet
- B. National Electrical Manufacturer's Association (NEMA)
1. NEMA 250-2014 Enclosures for Electrical Equipment (1,000-Volts Maximum)
- C. National Fire Protection Association (NFPA)
1. NFPA 70-2017 National Electrical Code (NEC)

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 27 30 01-1, Approval Drawings and Data:
1. Bill of Materials.
  2. Manufacturer's product data.
- C. RSN 27 30 01-2, Check Prints:
1. Drawings in government format:
    - a. Layout drawings.
    - b. Schematic diagrams.
    - c. Wiring diagrams
- D. RSN 27 30 01-3, Test Procedure and Test Schedule.
1. Detailed test procedure, identifying:
    - a. Equipment and systems being tested

- b. Methods of testing equipment and systems:
    - 1) Strategy
    - 2) Tools and test equipment to be used
    - 3) Metrics to be collected
    - 4) Number of equipment and system configurations to be tested
    - 5) Special requirements or procedures for testing, if any
  - c. Test criteria:
    - 1) Test data to be collected
    - 2) Pass/Fail criteria
    - 3) Proposed test result logs.
  - 2. Test schedule.
- E. RSN 27 30 01-4, Operations and Maintenance Manual:
- 1. Final drawings including “as-built” changes.
  - 2. Final Software Documentation.
  - 3. Spare parts list.
- F. RSN 27 30 01-5, Field Operational Checkout Test Report.
- 1. Certification of performance and results of test.

#### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store telephone equipment in accordance with manufacturer’s instructions. Include copy of these instructions with equipment at time of shipment.

#### **1.05 PROJECT CONDITIONS**

- A. Ambient Temperature Range: -40 to 40 degrees C.

#### **1.06 PERFORMANCE REQUIRMENTS**

- A. Voice over Internet Protocol (VOIP) System:
  - 1. Provide VOIP system network, to support connection of telephone system instruments (installed by Others). Installation of telephone system network includes installation of network components and cabling from interface with radio communication system out to telephone jacks at intended location of future telephone instruments.
  - 2. Installation of telephone network includes installation of local RJ-45 jacks for telephone connection.
  - 3. Functional testing of Contractor installed telephone network hardware.

4. Provide new cable of Category 6, network switches, wire, connectors, wall plates, telephone jacks, etc., to complete a working system.
- B. Provide for future expansion of additional phones.
- C. Provide list of recommended equipment that may be used to expand telephone system, including original manufacturer's equipment, and/or list of other vendor's phone system equipment, where applicable.
- D. System shall be able to support number in telephone instruments shown on drawing 1695-D-60528 plus 50 percent expansion.

### **1.07 EXTRA MATERIALS**

- A. Furnish following spare parts:
1. One network switch of each type or model supplied for this project.
  2. Spare parts shall be packed in containers suitable for long term storage.
  3. Spare parts shall bear labels clearly designating contents of equipment or components for which they are intended.
- B. Any additional equipment not specified in these specifications but necessary to make system complete and operational shall be provided by Contractor.

## **PART 2 PRODUCTS**

### **2.01 INDUSTRIAL NETWORK SWITCH**

- A. Rack-mounted, industrial, managed Ethernet switch.
- B. Physical Features:
1. Copper ports:
    - a. Ten 10/100BaseTX, RJ-45, PoE, minimum.
  2. Fiber ports: Two 100BaseFX, single-mode 1310nm, ST connectors.
  3. Up to 30-watts per PoE port.
  4. Status indicators on each port.
  5. Power: Redundant 24 VDC inputs.
  6. Enclosure: Metal case.
- C. Network Features:
1. IEEE 802.3 compliance.
  2. IEEE 802.3af/at compliance.

3. Full/Half Duplex operation on all ports.
4. 100-Mbps throughput, minimum.

## **2.02 MEDIA CONVERTERS**

- A. Industrial single mode fiber to Category 6 converter.
- B. Supports PoE over Category 6 cable with up to 30-watts per port.
- C. Two RJ-45 ports, minimum.
- D. PoE capable
- E. Power: 24 VDC input.
- F. Copper port:
  1. 10/100BaseTX, RJ-45, PoE, minimum.
- G. Fiber port:
  1. 100BaseFX, single-mode 1310nm.
- H. Operating temperature: -40 to 120 degrees F.

## **2.03 CAT 6 CABLE**

- A. In accordance with Section 26 05 10 – Conductors and Cables.

## **2.04 FACEPLATES AND CONNECTORS**

- A. Use registered jack (RJ) 45 modular connector.
- B. Provide each location with two (2) port RJ-45 faceplates unless otherwise noted on drawings.

## **2.05 NAMEPLATES AND DEVICE MARKINGS**

- A. Nameplates: As indicated on standard drawing 40-D-6234.
- B. Each principal device or item of system including chassis, modules, etc. that cannot be readily identified by markings or tags shall have identifiable nameplates.
- C. Locate nameplates for convenient observation by operational and maintenance personnel.
- D. Mark all interconnecting conductor and plug-in assemblies.
- E. Mount Red warning nameplates inside access openings of any equipment that contains hazardous voltages in excess of 50-volts. Mount warning nameplates as close as possible to hazards.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. In accordance with manufacturer's recommendations.
- B. Provide all mounting hardware and accessories to install telephone instruments.
- C. Install in accordance with drawing 1695-D-60528.
- D. Locate as specified on drawing 1695-D-283 and as directed by COR.
- E. Make cable and conduit connections. Use watertight conduit hubs for conduit connections.
- F. Provide necessary hazardous area certified equipment where required.
- G. Make power connections to equipment.
- H. Make grounding connections to existing grounding systems.
- I. Connections points for power shall be approved by COR.
- J. Gradual and uniform pulling stresses only will be permitted on cable.
- K. Where lubricant is needed as an aid to pulling of cable, only soapstone or other approved material not injurious to cable outer sheath shall be used.
- L. Make grounding and bonding connections in accordance with Section 26 05 20 – Grounding and Bonding.
- M. Make grounding connections to existing grounding systems.
- N. Cable and Wire Identification: In accordance with Section 26 05 10 – Conductors and Cables.

### **3.02 FIELD CHECKOUT**

- A. Notify Government in writing at least 15-days prior to beginning of tests.
- B. Testing will be witnessed by Government personnel. Government personnel will actively oversee testing.
- C. All material and equipment furnished under this contract shall be subjected to tests by Contractor, and at expense of Contractor at times and location specified.
- D. Furnish all necessary testing equipment and pay all cost of tests.

- E. Tests shall verify that system functional, performance, and design requirements as set forth in this solicitation are met.
- F. Perform Field Operational Checkout Test (FOC):
  - 1. Perform communications cable testing, including testing of all communications circuits including jacks or other termination devices, for all telephone system cabling.
  - 2. Verify operability of installed network switches, including energization of the switch and operability of network connections to the switch.
- G. Perform field wiring checkout and test in accordance with Section 26 05 10 – Conductors and Cables.
- H. Acceptance of equipment, or waiving of tests thereof, shall in no way relieve Contractor of responsibility of furnishing equipment and materials meeting specification requirements.

**END OF SECTION**

**SECTION 28 10 01**  
**SECURITY AND SURVEILLANCE SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Security and Surveillance System:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

National Electrical Manufacturer's Association (NEMA)

1. NEMA 250-2014 Enclosures for Electrical Equipment  
(1,000-Volts Maximum)

National Fire Protection Association, Inc. (NFPA)

2. NFPA 70-2017 National Electrical Code (NEC)

**1.03 SUBMITTALS**

A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.

B. RSN 28 10 01-1, Approval Drawings and Data:

1. Data:
  - a. Manufacturer's product data.
  - b. Electrical characteristics.
  - c. Bill of materials.
2. Drawings in government format:
  - a. Detailed installation drawings and instructions of system being provided.
  - b. Device, conduit and circuit plan layouts.
  - c. Schematic and wiring diagrams.

C. RSN 28 10 01-2, Test Procedure and Test Schedule.

1. Detailed test procedure, identifying:
  - a. Equipment and systems be tested.
  - b. Methods of testing equipment and systems:
    - 1) Strategy.

- 2) Tools and test equipment to be used.
    - 3) Metrics to be collected.
    - 4) Number of equipment and system configurations to be tested.
    - 5) Special requirements or procedures for testing, if any.
  - c. Test criteria:
    - 1) Test data to be collected.
    - 2) Pass/Fail criteria.
    - 3) Proposed test result logs.
  - 2. Test schedule.
- D. RSN 28 10 01-3, Test Report:
- 1. Certification of performance and results of test.
- E. RSN 28 10 01-4, Check Prints:
- 1. Schematic and wiring diagrams.
- F. RSN 28 10 01-5, Final Drawings and Operations and Maintenance Manuals:
- 1. Final Drawings including “As-built” changes.
  - 2. Operations and Maintenance Manuals.
  - 3. List of recommended spare parts and components.
  - 4. Final bill of materials.

#### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store equipment in accordance with manufacturer’s instructions. Include copy of these instructions with equipment at time of shipment.

#### **1.05 PERFORMANCE REQUIRMENTS**

- A. Any additional equipment not specified in these specifications but necessary to make system complete and operational shall be provided by Contractor.
- B. Provide all software essential for system to meet all functional requirements.
- C. Design video surveillance system to accommodate the following:
  - 1. IP based digital video surveillance system.
  - 2. Allows simultaneous live viewing and recording.
  - 3. Allows full resolution or low-resolution video, based on bandwidth limitations.

4. Supports streaming to allow users from remote (off-site) locations to stream video. Supports streaming full resolution, low resolution and still shots to remote locations.
  5. Pan/Tilt/Zoom (PTZ) camera control, with full remote control via IP network. Supports continuous scan of project site.
  6. Digital Video Recorder:
    - a. Automatic control and recording of each camera in the system.
    - b. Manual control of each camera in the system via keyboard, mouse and monitor.
  7. Cameras:
    - a. Limit stops shall be programmed to limit pan range of camera to wall adjacent to camera.
    - b. Pumping plant building:
      - 1) Camera shall power up upon entry indication into building and pan to opened door.
      - 2) Camera shall begin continuous scan of entire room once initial preset is reached.
    - c. Pumping plant yard:
      - 1) Allow coverage of entire treatment facility yard from camera(s) mounted in facility yard.
      - 2) Camera(s) shall provide continuous scan of entire facility yard.
- D. Placement:
1. Intrusion Detection:
    - a. For intrusion detection cameras shall be placed so that the intruder represents at least 10 percent of the image height (no less than 70-pixels) at normal camera image resolution.
    - b. All cameras shall be placed to provide intrusion detection, unless larger images are required.
  2. Locations:
    - a. Applies to all Contractor installed site locations.
    - b. Interior Process Areas:
      - 1) PTZ cameras.
      - 2) Coverage for all interior process areas.
      - 3) Coverage for all building entrances.
    - c. Site Perimeter:
      - 1) PTZ cameras.
      - 2) Coverage for site perimeter.

- d. Exterior Process Areas:
  - 1) PTZ cameras.
  - 2) Coverage for all exterior process areas.
- E. Design security system to accommodate the following:
  1. Keypad entry to allow keyless entry at one door for each building.
  2. Provide balanced magnetic contacts to monitor positions of all personnel doors, roll-up doors, entry gates and vault hatches.
  3. Balanced magnetic contacts shall indicate which gates, doors, and vaults are opened.
  4. Provide feedback from all supplied balanced magnetic contacts as input to SCADA system referenced in Section 25 00 01 – System Control and Monitoring.
- F. Access Control System:
  1. Control entry into the sites.
  2. IP/network based integrated system.
  3. Provides initial setup and management of system via Security System laptop computer:
    - a. Entry and modification of user access cards and access codes.
    - b. System hardware status.
  4. Primary Power Supply: Supply primary power for access control components from facility AC power system. Access control components shall not rely solely on local battery power supply.
  5. Backup Power Supply:
    - a. Battery supplied backup power for access control system to allow its continued operation upon loss of power. Sized for minimum duration of 90-minutes with doors operating throughout the period.
    - b. Allow continue operation of electronic access control system for doors throughout this period.
  6. Door Access Control:
    - a. Provide door access control utilizing card readers with keypads to allow entry to the building based on two factor authentications with individual employee access cards and individual access codes. System shall be capable of being set to bypass access codes during specific time periods and other conditions as agreed to by the Government.
    - b. Provide all necessary electronic locks, door hardware and other components required to implement specified system.
    - c. Support settable time period to control time duration doors are unlocked.

- d. Manual Keys:
    - 1) Provide a master key capable of operating all manual locks on entry doors and gates.
  - e. Minimum Card Reader with Keypad Locations:
    - 1) Building/structure entry doors. Provide card readers with keypads on all doors allowing access to the interior spaces within each building. If building interior walls do not allow all interior spaces to be access through one access door locate card readers and keypads to ensure that all interior spaces are accessible through a door with a card reader with keypad.
    - 2) Doors on opposite sides of the building for all buildings longer than 100 feet in any direction.
7. Door/Gate/Hatch Position Monitoring:
- a. Utilized balanced magnetic contacts to provide door, control panel, communication panels, security panels, and perimeter gate position monitoring unless the installation arrangement requires alternative method to monitor position. Video analyzation alone is not sufficient.
  - b. Provides specific indication of which entry point opened.
  - c. Minimum Locations:
    - 1) Doors or entry points for entering a building or structure. This includes personnel doors, equipment doors, and roll-up doors.
    - 2) Equipment control panels.
    - 3) Gates allowing entry to the site or through fences.
    - 4) All doors or entry points requiring card reader with keypad entry.
    - 5) Access hatches for vaults.
8. Door Hardware:
- a. Coordinate hardware with Section 08 71 00 – Door Hardware.
  - b. Provide electromechanical locksets for doors with Access Control System devices. Locksets shall be provided with integrated mortise locks to allow keyed entry through door.
9. Exit:
- a. Doors equipped for entry via Access Control System shall allow exit through mechanical exit device integrated with electromechanical locksets.
  - b. Door exit shall not require use of exit sensors and shall not be prevented by lockset or some other element of Access Control System.
  - c. Coordinate door hardware requirements with 08 71 00 – Door Hardware

10. Emergency Services Access:
  - a. Emergency services access, including fire department, via key locked access box for key storage, appropriately keyed for emergency services access.
  - b. Accessible outside of building.
  - c. Acceptable to the local fire marshal.
11. Alerts:
  - a. Support future network-based alarm to Access Control System Remote Command Center at San Juan Water Treatment Plant.
  - b. Provide hardwired (not network or communication based) alarms to SCADA system for system alarm or unauthorized entry.
12. System Integration:
  - a. Access Control System shall support future integration with Millennium Ultra based system located at remote San Juan Water Treatment Plant.
  - b. Shall allow setup and management of system from remote Security System Workstation/Server at the San Juan Lateral Water Treatment Plant.
  - c. Support modification to card and access code credentials for these facilities from San Juan Water Treatment Plant.

## **PART 2 PRODUCTS**

### **2.01 DIGITAL VIDEO RECORDER**

- A. On-Site Storage Requirements:
  1. 10-days at 10 frames per second, minimum.
- B. PTZ Control, with full remote control via TCP/IP network.
- C. Ports:
  1. 10/100BaseT Ethernet.
  2. Video Inputs: 4, minimum.
  3. Mouse and keyboard.
  4. USB ports: 3, minimum.
- D. Archive Devices:
  1. For long term storage, greater than 30-days.
  2. DVDRW.
  3. USB.

- E. Remote/Web-Client capable.
- F. Features:
  - 1. 720p.
  - 2. H.264 compression.
  - 3. HDMI.
- G. Monitor:
  - 1. Screen dimension, 24-inch minimum.
  - 2. Resolution: 1080p.
  - 3. Screen Type: Flat panel, LCD.
  - 4. Video input: HDMI.

## **2.02 PAN/TILT/ZOOM (PTZ) DOME CAMERAS**

- A. Type: Heavy Duty.
- B. Construction:
  - 1. Type: Pendant.
  - 2. Back box: Aluminum.
- C. Auto-focus.
- D. Zoom: 18x optical, minimum.
- E. Resolution: 720p, minimum.
- F. Power over Ethernet (PoE) capable.
- G. Outdoor camera to include the following:
  - 1. Enclosure: NEMA 4X.
  - 2. Dome: Smoked polycarbonate.
  - 3. Protective cage: Stainless steel.
  - 4. Day/Night mode.
  - 5. Operating temperature: -40 to 50 degrees C.
  - 6. High Powered PoE injector for heater element.
  - 7. Corner mounting for 270 degree view around plant.

## **2.03 INDUSTRIAL NETWORK SWITCH**

- A. Rack-mounted, industrial, managed Ethernet switch.

- B. Physical Features:
  - 1. Copper ports:
    - a. Ten 10/100BaseTX, RJ-45, PoE, minimum.
  - 2. Up to 30-watts per PoE port.
  - 3. Status indicators on each port.
  - 4. Power: Redundant 24 VDC inputs.
  - 5. Enclosure: Metal case.
- C. Network Features:
  - 1. IEEE 802.3 compliance.
  - 2. IEEE 802.3af/at compliance.
  - 3. Full/Half Duplex operation on all ports.
  - 4. 100-Mbps throughput, minimum.

#### **2.04 MEDIA CONVERTER**

- A. Industrial single mode fiber to Category 6 converter.
  - 1. Supports PoE over Category 6 cable with up to 30-watts per port.
  - 2. Power: 24 VDC input.
  - 1. Copper port:
    - a. 10/100BaseTX, RJ-45, PoE, minimum.
  - 2. Fiber port:
    - a. 100BaseFX, single-mode 1310nm.
  - 1. Operating temperature: -40 to 120 degrees F.
  - 2. Appropriate for use with installed system.

#### **2.05 ACCESS CONTROL SYSTEM COMPONENTS**

- A. Provide all necessary components, including site controllers, door controllers, keypads, card readers, electronic locks, power supplies, batteries, and similar required to implement specified system.
- B. All access control components shall have a primary power source supplied from facility power system and shall not rely solely on local battery power supply.
- C. System and provided key cards shall support use of both combination keypad and card readers as well as proximity card readers.
- D. Provide 20 key cards and all components needed to program the cards.

E. Keypad and Card Reader:

1. Card reader: Proximity type.
2. Keypad: 9 button keypad, minimum.
3. System capable of being set to bypass keypad.
4. Compatible with Site Control Unit and Access Control System Software.
5. Visual Indication:
  - a. Successful badge and code entry.
  - b. Alarm.
6. Keypad and card reader shall be vandal resistant anti-pull-off design.
7. Heavy duty all metal escutcheon.
8. Battery backup with continuous power connection to power supply.
9. Weatherproof, intended for outdoor installation.
10. UL listed.

F. Site Control Unit:

1. Millennium Enhanced Site Control Unit as manufactured by Millennium Group, 16 Tech Circle Suite 225, Natick, MA 01760, 866-455-5222, [www.mgiaccess.com](http://www.mgiaccess.com); or equal, having the following essential characteristics:
  - a. Supervisory Communications Monitor Relay.
  - b. Alarm Event Buffer: 100 priority event history.
  - c. Transaction History Buffer: 20,000 event on board storage.
  - d. Tamper Protection.

G. Access Control System Software:

1. Millennium Ultra as distributed by Millennium Group, 16 Tech Circle Suite 225, Natick, MA 01760, 866-455-5222, [www.mgiaccess.com](http://www.mgiaccess.com); or equal, having the following essential characteristics:
  - a. Compatible with existing Millennium Ultra systems.
  - b. Supports access and entry via specified methods.
  - c. Integrates with electronic locks, keypads and card readers.
  - d. Active directory login integration. Allows for limitation of system user permissions and daily activities.
  - e. Conditional and unconditional lock-down via any system event.
  - f. Event management, including pre-set system responses to system events such as unauthorized entries, intrusions or any specified event.
  - g. Hardware management.

- h. Hardware status indicators.
- i. Scheduling management, system administrator can set and edit card holder access schedules.
- j. Site management allows the system administrator to create and manage cardholder access restrictions through a single management screen.
- k. User and account management. Allows assignment of multiple credentials for system access to individual cardholders.

## **2.06 LOCK MORTISE**

- A. Heavy duty industrial design.
- B. In accordance with requirements of Section 08 71 10 – Door Hardware, and this Section.

## **2.07 POWER SUPPLY**

- A. Placed in cabinets to supply normal and backup power as required by system components in each facility.
- B. Input: 120 VAC.
- C. Outputs:
  - 1. Regulated and filtered.
- D. DC Output protection.
- E. AC Failure and Tampering Monitoring.

## **2.08 BALANCED MAGNETIC CONTACT**

- A. Designation: Balanced magnetic contact.
- B. Separate magnet housing and contact.
- C. All metal housing.

## **2.09 SURVEILLANCE SIGNS**

- A. Type: Aluminum construction.
- B. Size: 10- by 14-inches, minimum.
- C. Sign shall read “RESTRICTED AREA MONITORED BY VIDEO CAMERA”.

## **2.10 SURGE SUPPRESSION DEVICES**

- A. Type: Designed to protect outdoor cameras.

## **2.11 INSULATED CONDUCTORS**

- A. Insulated conductors used to wire security and surveillance system shall be in accordance with requirements of Section 26 05 10 – Conductors and Cables.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. In accordance with manufacturer's recommendations.
- B. All connections shall be made to place security and surveillance system into operation.
- C. Provide all cable and raceways required to connect Contractor supplied equipment and to provide fully functional system which meets requirements in these specifications. Cable and raceways shall be provided in accordance with Sections 26 05 10 – Conductors and Cables and 26 05 33 – Raceways and Boxes.
- D. Make grounding and bonding connections in accordance with Section 26 05 20 – Grounding and Bonding and NFPA 70.
- E. Mount keypad/card reader and door control device with suitable cable and raceway and as required for functional installation.
- F. Mount exterior security keypad/card reader within easy access to entry doors.
- G. Mount exterior security cameras on elevated standoffs on corners of structures at diagonally opposite corners to get optical coverage of all sides of the structure.
- H. Locate cameras as specified on drawings.
- I. Mount digital video recorder on shelf inside SCADA equipment cabinet.
- J. Place monitor in pumping plant control room.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Perform field wiring checkout and test in accordance with Section 26 05 90 – Wiring Checkout and Tests.
- B. Government will witness test. Notify COR in writing at least 20-days prior to beginning of Security and Surveillance system testing.
- C. Purpose of test is to demonstrate functionality, performance and stability of hardware and software.
- D. Test shall verify that all hardware and software meet requirements of specifications and drawings.

**END OF SECTION**

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**SECTION 28 31 00**  
**FIRE DETECTION AND ALARM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Fire Detection and Alarm:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. International Code Council (IBC)

1. IBC-2015 International Building Code (IBC)

B. National Fire Protection Association (NFPA)

1. NFPA 13-2016 Installation of Sprinkler Systems
2. NFPA 20-2016 Installation of Stationary Pumps for Fire Protection
3. NFPA 70-2014 National Electrical Code (NEC)
4. NFPA 72-2016 National Fire Alarm and Signaling Code
5. NFPA 90A-2015 Installation of Air Conditioning and Ventilating Systems
6. NFPA 90B-2015 Installation of Warm Air Heating and Air-Conditioning Systems
7. NFPA 92A-2009 Smoke-control systems Utilizing Barriers and Pressure Differences
8. NFPA 92B-2009 Smoke Management Systems in Malls, Atria and Large Spaces
9. NFPA 101-2015 Life Safety Code

C. Underwriters Laboratories, Inc. (UL)

1. UL 38-2008 Manual Signaling Boxes for Fire Alarm Systems
2. UL 94-2013 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
3. UL 268-2016 Smoke Detectors for Fire Alarm Systems
4. UL 268A-2008 Smoke Detectors for Duct Application

- |    |              |  |
|----|--------------|--|
| 5. | UL 864-2014  | Control Units and Accessories for Fire Alarm Systems |
| 6. | UL 1037-2016 | Antitheft Alarms and Devices                         |
| 7. | UL 1481-2006 | Power Supplies for Fire-Protective Signaling Systems |
| 8. | UL 1610-2016 | Central-Station Burglar Alarm Units                  |
| 9. | UL 1971-2002 | Signaling Devices for the Hearing Impaired           |
- D. National Electrical Manufacturer's Association (NEMA)
- |    |               |  |
|----|---------------|--|
| 1. | NEMA 250-2014 | Enclosures for Electrical Equipment (1,000-volts, Maximum) |
|----|---------------|--|

### 1.03 SUBMITTALS

- A. Submit the following in accordance with Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 28 31 00-1, Approval Data:
1. Manufacturer's data:
    - a. Include Manufacturer's name, model numbers, ratings, power requirements, and complete wiring point-to-point diagrams.
  2. Installation Company's current National Institute for Certification in Engineering Technologies (NICET) (minimum Level II Fire Alarm Technology) certification.
  3. Provide documentation to meet the following NFPA 72 Chapter 7 documentation requirements:
    - a. Written narrative providing intent and system description.
    - b. Riser diagram.
    - c. Floor plan layout showing locations of all devices, control equipment, supervising station and shared communications equipment.
    - d. Sequence of operation in either an input/output matrix.
    - e. Equipment technical datasheets.
    - f. Battery capacity and de-rating calculations.
    - g. Voltage drop calculations for notification appliance circuits.
    - h. Mounting height elevation for wall-mounted devices and appliances.
    - i. Minimum sound pressure levels that must be produced by audible notification appliances in applicable covered areas.
    - j. Pathway diagrams between control unit and supervising station, and shared communication equipment.

- C. RSN 28 31 00-2, Test Plan and Notification:
1. Include:
    - a. Detailed procedures for operational testing.
    - b. Signed by a NICET Level II fire alarm technician for performance of an operational system test.
- D. RSN 28 31 00-3, Test Reports:
1. Include completed record of completion in accordance with NFPA 72 7.5.6 and 7.8.2.
  2. Include certification from an authorized representative of the manufacturer that the installation complies with all manufacturers' requirements and that satisfactory total system operation has been achieved.
  3. Submit test reports bound together showing field tests performed to prove compliance with specified performance criteria, upon completion and testing of the installed system.
  4. Each test report shall document readings, test results and indicate final position of controls.
  5. Supply dates of testing and correctional items found during testing with remedies.
  6. Supply contact information including address, telephone, website for local certified fire alarm technician.
- E. RSN 28 31 00-4, As-built Drawings.
- F. RSN 28 31 00-5, Operation and Maintenance Instruction Book:
1. This submittal does not relieve Contractor of providing hard copy books to government personnel prior to training:
    - a. Rate of frequency in days, months, or years for each device to be tested. Rate of frequency shall be based on Manufacturer's recommendations and/or NFPA 72 testing requirements, whichever is more stringent.
  2. Copies of System Software (minimum two (2) copies).
  3. List of all system passwords and codes.
- G. RSN 28 31 00-6, Training Material.

#### **1.04 DEFINITIONS**

- A. FACU: Fire Alarm Control Unit. Definition in accordance with NFPA 72.
- B. IDC: Initiating Device Circuit. Definition in accordance with NFPA 72.
- C. NAC: Notification Appliance Circuit. Definition in accordance with NFPA 72.

D. SLC: Signaling Line Circuit. Definition in accordance with NFPA 72.

## 1.05 SYSTEM DESCRIPTION

A. General:

1. Contractor shall provide a system design which meets all listed codes and these specifications. Contractor shall certify that the documents produced meet and comply with all listed codes and the system is designed in accordance with said codes. Noting non-compliance on drawings or documents is not acceptable.
2. Contractor shall include designing, providing and commissioning the fire detection and alarm system to provide a complete coordinated system ready for operation. This system shall not be combined with other systems, such as automation or security systems.
3. Devices shall be rated for and have an operating temperature range suitable for the conditions at location where installed. Suitable enclosures shall be provided as required to insure installed condition of the device meets Manufacturer's recommendations. Where water may be present or splash hazards exist devices shall be installed in a manner suitable for wet locations.
4. Design and provide a fully addressable fire alarm system. System shall include, but not be limited to, the following as applicable:
  - a. FACUs.
  - b. Releasing Fire Control Panels
  - c. Fire Alarm Remote Annunciators.
  - d. Fire alarm transponders.
  - e. Automatic smoke and heat detection, including duct smoke detection.
  - f. Manual alarm initiation.
  - g. Audible and visual notification devices.
  - h. Alarm annunciation (local and remote).
  - i. Network connections.
  - j. Integration of ventilation fan, Air Handling Unit (AHU) or Energy Recovery Unit (ERV) controls into fire alarm system operation.
  - k. Damper interfaces.
  - l. All interface modules, interposing, auxiliary and time delay relays, enclosures, raceway, wiring, accessory components, etc., required for a complete and functional system in accordance with the Specification.
5. All devices for a complete system shall be manufactured by a single manufacturer or division thereof.
6. All devices and components shall be new and Manufacturer's current model.

7. Fire alarm system components requiring power, except for control panel power supply, shall operate on 24-Volts DC.
8. Releasing fire control panels:
  - a. Release signal conditions shall activate NACs to operate the fire suppression system.
  - b. Locate colored strobes to indicate the release of the agent inside area protected by the fire suppression system and outside the area at any doors entering protected area. Verify strobe color with COR prior to installation.
9. Fire alarm notification devices:
  - a. Provide audible alarm notification for fire alarm signals throughout buildings and structures of locations identified. Include sufficient devices to provide notification that meets sound level and visual evacuation requirements in listed codes.
  - b. System shall provide evacuation notification coverage for all occupiable areas throughout building.
  - c. System provided shall meet or exceed all listed codes as well as capabilities and coverage of installed system.
10. Fire alarm initiation devices:
  - a. Provide fire alarm initiation devices as required by all listed codes.
  - b. Include manual pull stations at all building exits.
  - c. Include duct detectors for ventilation fans, HVAC and ERV units where required by listed codes.
  - d. Automatic detection:
    - 1) Design and provide smoke detection to provide complete coverage for all buildings located at the facilities.
    - 2) Monitoring the operation of wet-pipe sprinkler systems where they exist may be provided in lieu of smoke detectors, where it meets requirements in the listed codes and meets the system requirement to provide an initiation signal for the smoke control system.
11. Fire alarm system external alarms:
  - a. Provide call out capability through cellular connection to local fire department.
  - b. Provide system fire alarm and trouble signals wired to the SCADA system.
12. Alarm signals, supervisory signals and trouble signals shall be distinctly transmitted to the FACU.

13. Provide fire personnel access boxes on exterior of building at main entrance. Verify location with COR prior to installation.
14. Connect all tamper switches, including those for fire personnel access boxes and outdoor enclosures for fire alarm system equipment, to the SCADA system.
15. Provide UL listed components where available.

B. Basic Performance:

1. Response time between alarm initiation (contact closure) and recording at main fire alarm control unit (appearance on alphanumeric read out) shall not exceed 5-seconds.
2. Any SLC between FACUs shall be wired Class X in accordance with NFPA 72.
3. IDCs shall be wired Class B in accordance with NFPA 72.
4. SLCs within buildings shall be wired Class B in accordance with NFPA 72. Individual signaling line circuits shall be limited to one chamber (either Gate Chamber or Helix Chamber) within Gate and Helix Structure.
5. Size each SLC to provide 40 percent expansion without hardware modifications to the panel.
6. NACs shall be wired Class B in accordance with NFPA 72.
7. All circuits associated with fire alarm system shall be supervised for integrity.
8. Any fire alarm wiring that extends outside of a building or structure shall have additional power surge protection to protect equipment from physical damage and false signals due to lightning, voltage and current induced transients. Protection devices shall be shown on submittal drawings.
9. Activation of the system into 'alarm mode' will occur by actuation of any alarm initiating device. System will remain in 'alarm' until initiating device is reset and the FACU is reset and restored to 'normal mode.'
10. A single ground or open on any initiating device circuit or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
11. In addition to IP communication interfaces the FACU shall communicate trouble and alarm status to the SCADA system via programmable relays.
12. Secondary power source will be capable of providing at minimum, 24-hours of backup power and the ability to sustain 15-minutes in alarm mode at the end of the backup period. Batteries will require a de-rating factor of 40 percent.

C. Damper Operation:

1. All alarm signals shall operate any fire/smoke dampers.
2. Provide position feedback from all fire/smoke dampers and dampers controlled by the system.

- D. All devices and components requiring access for maintenance activities or testing required by the listed codes shall be provided in accessible locations. Specific and unique accessibility limitations of Gate and Helix Chambers shall be accounted for in the final design. No device shall require scaffolding or lifts to reach.
- E. Coordinate fire alarm system design and installation with the following areas:
  - 1. Section 21 22 00 – Clean Agent Fire Extinguishing System.

## **1.06 QUALIFICATIONS**

- A. Manufacturer of equipment shall have produced similar electrical equipment for a minimum of 5-years.
- B. Design, system layout, document submittal preparation, and supervision of installation and testing shall be provided by a technician that is certified NICET level III or a registered fire protection engineer.
- C. NICET level III certified technician shall be onsite for supervision and testing of the system. Factory engineers from equipment Manufacturer, thoroughly familiar and knowledgeable with all equipment utilized, shall provide additional technical support at the site as required.
- D. Installers shall have a minimum of 2-years' experience installing fire alarm systems.

## **1.07 EXTRA MATERIALS**

- A. Two copies of site specific software for the fire alarm system and associated components.
- B. Furnish special tools and accessories required for installation, normal operation, and maintenance.
- C. Spare Parts:
  - 1. Manual Pull Stations: One of each type used.
  - 2. Notification Devices: One of each type used.
  - 3. Detection Devices: One of each type used.
  - 4. Duct smoke detectors with all appurtenances: One.

## **PART 2 PRODUCTS**

### **2.01 FIRE ALARM CONTROL UNIT (FACU)**

- A. FACU shall derive its normal power from a 120 VAC, 60 Hz dedicated supply with backup power from standby engine generator set. Standby power shall be provided by batteries, which are sized according to the requirements in NFPA 72:

1. Normal power shall be transformed, rectified, coordinated and interfaced with the standby batteries and chargers.
  2. Provide the FACU with protection from damage due to lighting or voltage and current transients.
  3. Each power source shall be supervised.
  4. Provide enclosures as required to house batteries and related components.
  5. Battery Chargers:
    - a. Completely automatic, with constant potential charger maintaining battery fully charged under all service conditions.
    - b. Shall be rated for fully charging a completely discharged battery within 48-hours while simultaneously supplying any loads connected to the battery.
    - c. Shall have protection to prevent discharge through the charger.
    - d. Shall have protection for overloads and short circuits on both AC and DC sides.
    - e. Trouble condition shall actuate the fire alarm trouble signal.
    - f. Charger shall have automatic AC line voltage regulation and automatic current-limiting features.
  6. Batteries:
    - a. Sealed, maintenance-free lead acid battery.
    - b. Casing: Rugged construction, high-impact.
  7. Provide power supplies UL listed meeting the requirements of UL 1481.
- B. Addressable Fire Alarm Control Panel with Voice Evacuation System and Digital Alarm Communicator/Transmitter (DACT) manufactured by Fire-Lite Alarms, <https://www.firelite.com>, Type MS-9600; or equal, having the following essential characteristics:
1. Addressable FACU with sufficient point capacity to implement Contractor designed fire alarm system.
  2. Supervise and monitor all initiating device circuits and alarm notification circuits for trouble and alarm conditions.
  3. Detect the operation of any initiating device circuit and location of alarm condition.
  4. Operate all notification appliance devices as designed.
  5. Visually and audibly annunciate any trouble, supervisory or alarm condition on the panel display.
  6. Capable of strobe synchronization.

7. Transmit digital alarm information to the main FACU, if multiple FACUs at the facility.
8. System shall have built in digital communicator with the following capabilities:
  - a. Dual path communicator for fire alarm control panels capable of supporting either cellular (GSM) or IP communication and settable to either cellular only, IP only or both.
  - b. Supports HSPA+, HSPA, EDGE and GPRS communication protocols and compatible with Honeywell AlarmNet system.
  - c. Cellular communicator shall be intended for interface with fire alarm control panels supplied and shall interface with primary and secondary communication ports from fire alarm control panel.
  - d. Cellular communicator shall be housed in FACP enclosure its own enclosure and powered from fire alarm control panels.
  - e. Includes an external antenna.
9. Programmable, with multiple levels of passwords. Allows uploading of setting files from external computer.
10. Programmable relays: Quantity as required.
11. IP communicator compatible.
12. System shall include a history log with a minimum of 500 event storage. History shall be accessible from main system display.
13. System shall include a real-time clock/calendar.
14. Automatic detector sensitivity testing per NFPA 72.
15. System shall have local indication of the status of the following system parameters:
  - a. Power.
  - b. Fire Alarm.
  - c. Supervisory.
  - d. Trouble.
  - e. Alarm Silenced.
16. Display:
  - a. Integral minimum 80-character liquid crystal display (LCD) with backlighting.
  - b. Allows fire alarm verification (by device or zone).
  - c. Provides sufficient information to identify location of devices in alarm and perform system troubleshooting.

17. System shall be capable of the following operations:
  - a. Acknowledge/Silence:
    - 1) Silences audible alert of troubles and supervisory conditions at the FACU. Occurrence of any new conditions in the system shall cause audible alert to re-assert.
    - 2) Operation shall also silence the audible alert at any remote annunciators.
  - b. Alarm Silence: Silences all alarm notification appliances and returns them to normal condition after an alarm condition.
  - c. System Reset: Causes all electronically-latched initiating devices, as well as all associated output devices and circuits, to return to their normal condition.
  - d. Alarm Activate (Drill): Activates all notification appliance circuits without activating the DACT.
  - e. Lamp Test: Activate system LEDs and light each segment of the LCD.
18. FACU shall have lockable enclosure.
19. UL listed meeting the requirements of UL 864.

## **2.02 RELEASING FIRE CONTROL PANEL**

- A. Releasing Fire Control Panel shall derive its normal power from a 120 VAC, 60 Hz dedicated supply with backup power from standby engine generator set. Standby power shall be provided by batteries, which are sized according to the requirements in NFPA 72:
  1. Normal power shall be transformed, rectified, coordinated and interfaced with standby batteries and chargers.
  2. Provide the FACU with protection from damage due to lightning or voltage and current transients.
  3. Each power source shall be supervised.
  4. Provide enclosures as required to house batteries and related components.
  5. Battery Chargers:
    - a. Completely automatic, with constant potential charger maintaining battery fully charged under all service conditions.
    - b. Shall be rated for fully charging a completely discharged battery within 48-hours while simultaneously supplying any loads connected to the battery.
    - c. Shall have protection to prevent discharge through the charger.
    - d. Shall have protection for overloads and short circuits on both AC and DC sides.

- e. Trouble condition shall actuate the fire alarm trouble signal.
  - f. Charger shall have automatic AC line voltage regulation and automatic current-limiting features.
6. Batteries:
    - a. Sealed, maintenance-free lead acid battery.
    - b. Casing: Rugged construction, high-impact.
  7. Provide power supplies UL listed meeting the requirements of UL 1481.
- B. FSCU manufactured by Fire-Lite Alarms, [www.firelite.com](http://www.firelite.com), Type MRP-2002; or equal, having the following essential characteristics:
1. UL listed. Panel shall meet requirements of UL 864.
  2. Supervise and monitor initiating device circuits and notification circuits for trouble and alarm conditions.
  3. Supports appropriate number of releasing circuits required for suppression implementation. Includes supervision of releasing circuits.
  4. Programmable soak time delay, minimum range 10-30 minutes.
  5. Programmable function to allow self-resetting devices to trigger additional releases, non-latching.
  6. Visually and audibly annunciate any trouble, supervisory or alarm condition on panel display.
  7. Programmable output circuits.
  8. Programmable relays.
  9. Capable of strobe synchronization.
  10. Built-in programmer.
  11. System shall include history log with a minimum 250 event storage. History shall be accessible from main system display.
  12. Include the following displays mounted on panel:
    - a. LCD display with keypad.
    - b. LED indicators.
  13. System shall be capable of the following operations:
    - a. Acknowledge/step switch.
    - b. Alarm silence switch.
    - c. System reset switch.
    - d. Lamp test function.
    - e. Alarm activate (drill).

### **2.03 MANUAL PULL STATION**

- A. Addressable manual pull station having the following characteristics:
1. Adjustable addressable module to be housed inside pull station.
  2. Dual-action with key-lock reset.
  3. Clearly labeled “Fire” on the cover with label visible from all viewing directions.
  4. Compatible with FACU.
  5. Meet Americans with Disabilities Act (ADA) requirements for a 5-pound maximum pull force.
  6. Contain Braille text on handle.
  7. UL listed meeting the requirements of UL 38.

### **2.04 ADDRESSABLE PHOTOELECTRIC SMOKE DETECTOR**

- A. Addressable photoelectric detector having the following characteristics:
1. Plug-in design for easy mounting.
  2. Compatible with the FACU.
  3. Adjustable addressing per device.
  4. Built-in tamper-resistance.
  5. Removable cover with insect-resistant screen for simple field cleaning.
  6. Capable to withstand air velocities up to 4,000 feet per minute without false alarming.
  7. Visible communication identification.
  8. Visible alarm state identification.
  9. Mounting: Direct surface or electrical box.
  10. Rated V-0 for plastic flammability per UL 94.
  11. Sealed against back pressure.
  12. Sensitivity: 1.5-percent/foot nominal.
  13. Voltage: 24VDC.
  14. UL listed meeting the requirements of UL 268.

### **2.05 PROJECTED BEAM SMOKE DETECTOR**

- A. Model 6424 Projected Beam Detector by System Sensor, [www.systemsensor.com](http://www.systemsensor.com), Catalog #: 6424; or equal, having the following essential characteristics:
1. Projected beam smoke detector including transmitter and receiver.
  2. Compatible with the FACU.

3. Built in automatic gain compensation.
4. Visible alarm state identification.
5. Voltage: 24VDC.
6. Device shall be rated for and have an operating temperature range suitable for location where installed. Suitable enclosures shall be provided if needed to insure that conditions for the device are in accordance with Manufacturer's recommendations.
7. UL listed meeting the requirements of UL 268.
8. Include remote test station.

## **2.06 DUCT SMOKE DETECTOR**

- A. InnovairFlex Intelligent Non-Relay Photoelectric Duct Smoke Detector by FireLite Alarms, [www.firelite.com](http://www.firelite.com), Catalog #: D355PL; or equal, having the following essential characteristics:
1. Intelligent non-relay photoelectric duct smoke detector.
  2. Compatible with the FACU.
  3. Housing shall be pivoting to allow for fit in both square and rectangular footprints capable of mounting to a round or rectangular duct.
  4. Airflow velocity range: 100 to 4,000 feet/minute.
  5. Operating Temperature Range: -20 to 70 degrees C.
  6. Sensor head shall be easily accessible for maintenance.
  7. Tamper feature indicating a trouble signal for a removed or improperly installed sensor cover.
  8. Front or back mounting of sampling tube with no required tools.
  9. Clear cover for visual inspection.
  10. Remote testing capable.
  11. UL listed meeting the requirements of UL 268A.
- B. Remote Test Station by FireLite Alarms, [www.firelite.com](http://www.firelite.com), Catalog #: RTS151KEY; or equal, having the following essential characteristics:
1. Remote test station for duct smoke detector.
- C. Weather resistant housing:
1. NEMA 4 rated housing. Watertight, UV resistant enclosure providing protection against falling dirt, rain, and windblown dust, splashing and hose directed water.
  2. Housing must be compatible with duct smoke detector.

- D. Metal sampling tubes:
  - 1. Metal sampling tubes compatible with duct smoke detector.
  - 2. Tubing shall be purchased and installed to fit duct work size.

## **2.07 WATERFLOW AND PRESSURE SWITCHES**

- A. Wet pipe water flow switches and dry pipe alarm pressure switches for sprinkler systems; shall be monitored by the FACU:
  - 1. Tamper resistant cover.
  - 2. NEMA 4 enclosure.
  - 3. Includes alarm transmission delay time that is conveniently adjustable from 0- to 60-seconds. Initial settings shall be 30-45 seconds. Timing shall be recorded and documented during testing.
- B. All new water flow switches shall be of a single Manufacturer and series and non-accumulative retard type.

C. UL listed.

## **2.08 SPRINKLER AND STANDPIPE SUPERVISORY SWITCHES**

- A. Valve supervisory switches shall be monitored by the FACU.
- B. Mechanism shall be contained in weatherproof die-cast aluminum housing that shall provide 3/4-inch (19-mm) tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.
- C. Entire installed assembly shall be tamper-proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting.
- D. Where dry-pipe sprinkler systems are installed, high and low air pressure switches shall be provided and monitored by way of an address reporting interface devices.
- E. UL listed.

## **2.09 STROBE NOTIFICATION DEVICE**

- A. Wall mounted clear strobe notification device:
  - 1. Clearly labeled "Fire" on the cover with label visible from all viewing directions.
  - 2. Strobe light shall be a xenon flash tube.
  - 3. Strobe rate: One (1) flash per second.
  - 4. Compatible with the FACU.
  - 5. Red housing.

6. Candela: Minimum 15-110 selectable.
7. Voltage: 24VDC.
8. Shall connect via synchronization module compatible with both notification device and fire alarm control unit.
9. UL 1971 listed.

## **2.10 HORN/STROBE NOTIFICATION DEVICE**

- A. Output speaker/strobes having the following characteristics:
1. Wall mounted clear horn/strobe.
  2. Clearly labeled "Fire" on the cover with label visible from all viewing directions.
  3. Strobe light shall be a xenon flash tube.
  4. Speakers shall have high fidelity sound output.
  5. Red housing.
  6. Candela: Minimum 15-110 selectable.
  7. Strobe rate: One (1) flash per second.
  8. Operating Voltage: 24VDC.
  9. Compatible with the FACU.
  10. Shall connect via synchronization module compatible with both notification device and the FACU.
  11. UL listed.

## **2.11 UTILITY LOCKS AND KEYS**

1. All key operated test switches, control units, annunciator panels and lockable cabinets shall be provided with single standardized utility lock and key.
2. Key operated manual fire alarm stations shall have single standardized lock and key separate from control equipment.
3. All keys shall be delivered to COR.

## **2.12 FIRE PERSONNEL ACCESS BOXES**

- A. Knox-Box 3200 Series by Knox Company, [www.knoxbox.com](http://www.knoxbox.com), Knox-Box 3200 Series; or equal having the following essential characteristics:
1. Hinged Door.
  2. UL listed alarm tamper switches.
  3. 1/2-inch thick steel door with interior gasket seal and stainless steel door hinge.
  4. 1/8-inch thick stainless steel dust cover with tamper seal mounting capabilities.

5. Double action rotating tumblers and hardened steel pins accessed by a biased cut key.
6. Capable of holding up to 10 keys and access cards.
7. Suitable for outdoor installation.
8. UL listed 437, 1037, and 1610 listed.

## **2.13 SOFTWARE AND LICENSES**

- A. Windows based software.
- B. Provide software licenses required to operate, maintain, and program systems.
- C. Government will make up to two copies of licensed software for backup purposes.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Provide and test microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, and coordinated system as described in this Section.
- B. Install all work as shown and specified herein, in accordance with NFPA 70, NFPA 72, NFPA 90A, NFPA 90B, NFPA 101, and in accordance with Manufacturer's diagrams and recommendations.
- C. Provide end of line resistors as needed.
- D. Provide lockable, red marked, circuit breaker dedicated to power each fire alarm panel and external batteries dedicated to fire alarm systems; label circuit breaker as indicated. See panelboard schedules for specific circuit location. A lockable breaker is accomplished by using a circuit breaker lock that is listed for use with the circuit breaker and that allows breaker to trip, but does not allow tampering with breaker.
- E. All boxes and cabinets associated with the fire detection and alarm system shall be factory painted red. Upon complete installation, contractor shall touch up paint as needed.
- F. Smoke detectors shall not be installed until construction is essentially complete and building has been thoroughly cleaned.
- G. All fire alarm panels shall be mounted so that no part of the enclosing cabinet is less than 30-inches or more than 78-inches above finished floor.
- H. Detectors shall be at least 12-inches from any part of any lighting fixture.

- I. Detectors shall be located at least 3-feet from diffusers of air handling systems.
- J. Notification appliances shall be mounted 80-inches above finished floor or 6-inches below the ceiling, whichever is lower.
- K. Where possible locate water flow and pressure switches a minimum of 12-inches from a fitting that changes the direction of flow and a minimum of 36-inches from a valve.
- L. Ground equipment in accordance with listed codes, manufacturer's recommendations and Section 26 05 20 – Grounding and Bonding.
- M. Raceway and Conductors:
  - 1. Install conduit and conductors in accordance with fire alarm system Manufacturer's recommendations, listed codes, Sections 26 05 10 – Conductors and Cables and 26 05 33 – Raceways and Boxes.
  - 2. Fire alarm wiring shall be installed in conduit.
  - 3. Cable type shall be as specified in NFPA 70 Article 760.
  - 4. Wiring for the fire alarm system shall not be installed in conduits, junction boxes or outlet boxes with conductors of other systems.
  - 5. Fire detection and alarm conduit and conduit accessories shall be dedicated to this system.
  - 6. Conduits shall be 3/4-inch minimum. Conduit fill shall not exceed requirements in NFPA 70.
  - 7. Inside cover of all junction boxes must be painted red and identified as "Fire Alarm".

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Submit for approval at least 30-days prior to commencement of formal operational testing. Include detailed procedures for operational testing of each fire detection and alarm component prepared and signed by NICET Level III fire alarm technician for performance of an operational system test.
- B. Perform operational and functional tests in presence of Government's representative identified by COR.
- C. Notify COR in writing at least 10-days in advance of each testing session.
- D. Operational Test:
  - 1. Perform fire detection and alarm testing in witness of Government Representative and facility operators.
  - 2. Demonstrate each detection device operates per Manufacturer's instructions.
  - 3. Demonstrate operation of voice evacuation system including use of pre-recorded messages and manual messaging through the microphone.

4. Demonstrate system operation from each of the remote annunciators.
  5. Perform operation test of the smoke control system in accordance with the requirements in this specification and in accordance with 01 80 15 – Commissioning.
  6. Upon completion of successful testing, provide all documentation, security codes, replacement devices, and other relevant material to Government representative.
- E. Test Report:
1. Submit test reports bound together showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system.
  2. Each test report shall document readings, test results and indicate the final position of controls. Include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.
  3. Provide dates of testing and correctional items found during testing with remedies.
  4. Supply contact information including address, telephone, website, etc. for local certified fire alarm technician.

### **3.03 TRAINING**

- A. Coordinate training with COR. Notify COR a minimum of 60-days prior to start of training.
- B. Submit lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. Provide a minimum of ten hard copies of the training material.
- C. Operations training shall familiarize designated government personnel with proper operation of the fire alarm system.
- D. Conduct the course in building where the system is installed or as designated by COR.
- E. Instructions shall cover items contained in the operating and maintenance instructions book.
- F. In addition, training shall be provided on performance of expansions or modifications to the fire detection and alarm system.
- G. Maintenance training course shall provide designated government personnel adequate knowledge required to diagnose, repair, maintain and expand functions inherent to the system.
- H. Manuals shall be provided prior to training outlining step-by-step procedures required for system startup, operation and shutdown.

- I. Manual shall include Manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.

**END OF SECTION**

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**SECTION 31 02 10**  
**WATER FOR DUST ABATEMENT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Water for Dust Abatement:
1. Measurement: Volume of water applied for dust abatement as directed by COR:
    - a. Only water used for dust abatement as directed by COR will be included.
    - b. Quantity will be measured by calibrated water meter approved by COR.
  2. Payment: M (1,000) gallons prices offered in the Price Schedules.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 02 10-1, Meter Calibration.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 APPLYING WATER FOR DUST ABATEMENT**

- A. Provide sealed calibrated water meter for use in measuring water usage.
- B. Provide water in accordance with Section 01 51 00 – Temporary Utilities.
- C. Provide means of conveying water to point of use and applying water.
- D. Install water meter at source.
- E. Use pressure spray or distributor bar to apply water evenly.
- F. Do not use water for dust abatement on temporary equipment roads, compacted backfill areas, and other construction activities unless directed by COR.
- G. Apply water for dust abatement as directed by COR.

**END OF SECTION**

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**SECTION 31 02 30**  
**DUST PALLIATIVE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Dust Palliative:
1. Measurement: Area covered as approved by COR.
    - a. Only palliative applied in areas approved by COR will be included.
  2. Payment: Acreage price offered in the Price Schedules.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 02 30-1, Proposed Application Area for Dust Palliative:
1. Include dust palliative composition, equipment and application.
  2. Certification that dust palliative does not inhibit revegetation.

**PART 2 PRODUCTS**

**2.01 DUST PALLIATIVE**

- A. Dirtglue, as manufactured by Dirtglue Enterprises, [www.dirtglue.com](http://www.dirtglue.com), or equal, with the following essential characteristics:
1. Biodegradable.
  2. Water based.
  3. Will not inhibit revegetation.

**2.02 WATER**

- A. Required for mixing and application.

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. Surface Preparation:
1. Shape and grade surface.
  2. Loosen surface with rock rake or blade grader to depth of 1- to 2-inches.

3. Water loose surface so it is visibly moist.
4. In areas without surfacing materials: Do not disturb subgrade, moisten only.

### **3.02 APPLICATION**

- A. Apply in areas approved by COR immediately after clearing, grubbing and top soil stockpiling have been completed:
- B. Apply palliative to cleared and grubbed areas not disturbed by excavation, stockpiled top soil materials, roads, access ramps.
- C. Do not apply to areas to be excavated unless directed by COR.
- D. After backfill and top soil has been replaced.
- E. Other areas as directed by COR where application of water for dust abatement is ineffective as determined by COR.
- F. Perform maintenance applications to control dust for duration of contract as recommended by manufacturer and as directed by COR.
- G. Apply within 24-hours after completion of surface preparation.
- H. Equipment: Designed for uniform application on variable widths at predetermined rates.
- I. Location: Access road, stockpiles and ROW as directed by COR.
- J. Area: Surface width as necessary with designated ROW.
- K. Limitations:
  1. Not during rain.
  2. Not if rain is anticipated within 4-hours following treatment.
  3. Not on frozen ground.
- L. Application Rate:
  1. Dust Palliative: As recommended by manufacturer.
  2. If material runs off during application, make repeated passes at lesser rates.
- M. Compaction:
  1. By equipment travel.
  2. Keep traffic off treated surface until dust palliative has penetrated and cured enough to prevent excessive pickup under traffic.

**END OF SECTION**

**SECTION 31 03 33**  
**REMOVAL OF WATER FROM EXCAVATION**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in applicable prices offered in the Price Schedules for items of work requiring removal of water from excavations.

**1.02 DEFINITIONS**

- A. Dewatering: Removal and control of groundwater from pores or other open spaces in soil or rock formations to allow construction activities to proceed as intended, and includes relief of groundwater pressure, control and discharge of effluent water.
- B. Unwatering: Control and removal of ponded, seeping, or flowing surface water or emerging subsurface water from excavated surfaces and from precipitation within and adjacent to excavations and construction zones using channels, ditches, gravel drains, gravel blankets, pipe, sumps, and discharge lines. Includes control and discharge of effluent waters.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 03 33-1, Removal of Water Plan:
1. Showing proposed method for removal of water from foundations:
    - a. Include proposed equipment for removal of water, including pump sizes, etc.
  2. Removal of Water Plan may be placed in operation upon approval, but nothing in this paragraph shall relieve Contractor from full responsibility for adequacy of water removal installation.

**1.04 SYSTEM DESCRIPTION**

- A. Design, install, operate, maintain, and monitor water removal facilities.
- B. Design and layout facilities to collect discharge water from water removal systems and convey water to designated approved discharge points.
- C. Locate water removal facilities to maximize water removal and minimize construction interference.

- D. Select pump types and design discharge systems and settling ponds.
- E. Provide required equipment and monitor as required by permit.

### **1.05 PROJECT CONDITIONS**

- A. Conditions which may influence unwatering include:
  - 1. Frequency and rate of precipitation at the site.
  - 2. Subsurface conditions including natural layering, thickness, permeability, and storativity of materials, and groundwater levels.
  - 3. Efficiency of pumps, collectors, and discharge systems.
- B. Water content and water levels in subsurface materials vary with location, depth, and material.
- C. Refer to Section 53 20 00 – Records of Geologic and Subsurface Investigations.

### **1.06 REGULATORY REQUIREMENTS**

- A. Obtain required Federal, State, Tribal and local permits for water discharge and other activities associated with removal and control of water.
- B. Refer to Section 01 57 30 – Water Pollution Control.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 REMOVAL OF WATER**

- A. Provide, maintain, and operate necessary facilities for removal of water from various parts of the work and for maintaining foundations and other parts of work free from water as required for constructing each part.
- B. Where excavation for pipe trenches and excavation for structures extends below ground-water level, dewater portion below water level in advance of excavation.

### **3.02 UNWATERING**

- A. Use ditches or sumps to lower and control water levels in advance of excavation, as approved by COR.

- B. Construct ditches and sumps to collect seepage and runoff in work areas. Use sandbags, sand and gravel filter bedding, and other materials and techniques to control localized seepage.

### **3.03 DEWATERING**

- A. Accomplish dewatering by use of sufficient number of properly screened wells or other equivalent methods.
- B. Dewater to prevent loss of fines from foundation, maintain stability of excavated slopes and bottom of excavations, and to result in construction operations being performed in the dry.

**END OF SECTION**

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**SECTION 31 11 00**  
**CLEARING AND GRUBBING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for other items of work.

**1.02 DEFINITIONS**

- A. Vegetation: Trees, shrubs, brush, stumps, exposed roots, down timber, branches, grass and weeds.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. Obtain inspection and permits before clearing and grubbing.
- B. Obtain COR approval before clearing and grubbing.

**3.02 CLEARING**

- A. Clear only areas to be stripped of topsoil.
- B. Clear rights-of-way to be occupied by permanent construction.
- C. Clear adjacent to cut or fill sections to a minimum distance of 3-feet outside of slope lines.
- D. Obtain COR approval before removing trees.
- E. Remove vegetation, rubbish, and objectionable material as determined by COR.
- F. Clear areas in accordance with Sections 01 57 50 – Tree and Plant Protection and 01 57 60 – Protected Species.

**3.03 DISPOSAL OF CLEARED MATERIAL**

- A. Dispose of material in accordance with Section 01 74 00 – Cleaning and Waste Management, or as directed by COR.

**END OF SECTION**

**SECTION 31 14 10**  
**TOPSOIL STRIPPING, STOCKPILING AND PLACEMENT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Common Excavation for Structures.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. Obtain COR approval before clearing and grubbing and stripping.
- B. Strip all areas to be disturbed to expose unknown cultural resources directly after mobilization. Refer to Section 01 57 90 – Preservation of Historical and Archeological Data if cultural resources are discovered.

**3.02 STRIPPING**

- A. Remove topsoil in areas to be disturbed to a depth of 6-inches, and to additional depths where directed by COR:
  1. If a true topsoil structure does not exist, consider surface soils removed to be topsoil for purpose of this section.
  2. If surface is rock, stripping not required.

**3.03 STOCKPILE**

- A. Stockpile for future use or haul offsite in accordance with Section 31 23 39 – Disposal of Excavated Materials.
- B. Do not compact topsoil in stockpile.
- C. Cover stockpile with a non-permeable tarp or dust palliative as approved by COR.

**3.04 PLACEMENT**

- A. Remove trash, weeds, stones larger than 3-inches, and large pieces of vegetative materials.
- B. Place topsoil in areas of earthen surface disturbed by construction.
- C. Place topsoil to a minimum thickness of 6-inches.
- D. Limit equipment travel over topsoil to avoid compaction.

**END OF SECTION**

**SECTION 31 23 02**  
**COMPACTING EARTH MATERIALS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include cost of compacting earth materials in prices offered in the Price Schedules for items of work where earth materials are required to be compacted:
  - a. Includes:
    - 1) Furnishing water and moistening materials.
    - 2) Contractor Quality Testing.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |     |                        |  |
|-----|------------------------|--|
| 1.  | ASTM D422 - 63(2007)e2 | Particle-Size Analysis of Soils  |
| 2.  | ASTM D653 - 14         | Terminology Relating to Soil, Rock, and Contained Fluids   |
| 3.  | ASTM D698 - 12e2       | Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> )) |
| 4.  | ASTM D1140 - 17        | Amount of Material in Soils Finer than the No. 200 (75- $\mu$ m) Sieve   |
| 5.  | ASTM D1556 - 15e1      | Density and Unit Weight of Soil in Place by the Sand-Cone Method   |
| 6.  | ASTM D2216 - 10        | Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass  |
| 7.  | ASTM D2487 - 11        | Classification of Soils for Engineering Purposes (Unified Soil Classification System)  |
| 8.  | ASTM D2488 - 09a       | Description and Identification of Soils (Visual-Manual Procedure)  |
| 9.  | ASTM D4318 - 10e1      | Liquid Limit, Plastic Limit, and Plasticity Index of Soils   |
| 10. | ASTM D4564 - 08e1      | Density of Soil in Place by the Sleeve Method  |

- |     |                  |  |
|-----|------------------|--|
| 11. | ASTM D4718 - 15  | Correction of Unit Weight and Water Content for Soils Containing Oversize Particles  |
| 12. | ASTM D4914 - 16  | Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit   |
| 13. | ASTM D5030 - 13a | Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit  |
| 14. | ASTM D5080 - 17  | Rapid Determination of Percent Compaction  |
| 15. | ASTM D6938 - 17  | In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depths)                                    |
| 16. | ASTM D7382 - 08  | Determination of Maximum Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibrating Hammer |

B. Bureau of Reclamation (USBR)

1. *Guidelines for Earthwork Construction Control Testing of Gravelly Soils*, Earth Sciences and Research Laboratory, Technical Service Center, Bureau of Reclamation, Denver, Colorado, September 2008.

### 1.03 DEFINITIONS

- A. Use definitions from ASTM D653.
- B. Control Fraction: Portion of a soil sample consisting of particles smaller than a designated sieve size. Fraction is used to compare in-place unit weight with standard laboratory unit weight. Control sieve size depends on laboratory test used to determine laboratory maximum density.
- C. C-Value: Ratio expressed as a percentage of (1) in-place unit weight at fill moisture content to (2) wet unit weight of laboratory-compacted specimen prepared at fill moisture content as determined by rapid method of construction control in accordance with ASTM D5080. C-Value is a comparison of compactive effort of field compaction equipment to standard laboratory compactive effort.
- D. D-value: Ratio expressed as a percentage of (1) in-place wet unit weight at fill moisture content to (2) laboratory maximum wet unit weight as determined from compaction curve constructed at fill moisture content as determined by rapid method of construction control ASTM D5080. D-value is equivalent of percent compaction in accordance with ASTM D698.
- E. Percent Compaction: Percent compaction of a cohesionless soil where the laboratory maximum density is determined by Maximum Dry Unit Weight test in accordance with ASTM D7382.

- F. Special compaction: Compaction close to structures or in spaces not accessible by standard width rollers.

#### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 23 02-1, Test Results:
  - 1. Results of tests listed in Table 31 23 02A – Contractor Materials Testing Requirements and Frequency.
  - 2. Include test date, time, location and person performing tests.
  - 3. Notify COR within 2-hours if testing does not meet specified requirements.

#### **1.05 AMBIENT CONDITIONS**

- A. Do not place and compact soil under the following conditions:
  - 1. Rain or seepage that creates puddles in clayey or silty materials.
  - 2. Heat or wind that dries material below specified moisture conditions.
  - 3. Ice, frost, or snow pockets that are visible in soil being placed or on working surface.
- B. Ambient air temperature below freezing may make placement and compaction operations difficult:
  - 1. Minimize interruptions of operations.
  - 2. Continuous operations may be required to eliminate freezing of materials.
  - 3. Obtain COR approval before performing operations when ambient air temperatures are below freezing.
  - 4. Cease operations when placed materials are freezing or below freezing.

### **PART 2 PRODUCTS**

#### **2.01 CLASSIFICATION**

- A. When required, classify earth materials using the Unified Soil Classification System (USCS) according to ASTM 2487 or ASTM D2488:
  - 1. Gradation tests for classification: ASTM D422 or ASTM D1140.
  - 2. Atterberg limits testing for classification: ASTM D4318.

## **2.02 SOIL TYPES**

### **A. Clean Fill:**

1. Any soil except soils with classifications Peat (PT), Organic Silts and Organic Clays (OL and OH), or Elastic Silt (MH) per ASTM D2487.
2. Free of roots, stumps, limbs, vegetation, organic matter, and ice.
3. Does not contain construction debris, scrap materials, refuse, man-made wastes, or chemical or hydro-carbon contamination.

### **B. Do not use frozen soils.**

### **C. Special Gradations and Plasticity:**

1. In some cases, such as embankment materials embedment for buried pipe, special gradations and/or plasticity characteristics may be required. These requirements are provided in applicable Section.

## **2.03 DESIGNATION OF SOILS FOR COMPACTION**

### **A. Requirements for lift thickness, method of compaction, and method of determining degree of compaction depends on whether soil is considered to be silty or clayey, cohesionless, or cohesionless containing some silt and clay.**

### **B. Silty or Clayey Soils:**

1. Contains appreciable amounts of fines (more than 15 percent plastic fines or 30 percent non-plastic fines).

### **C. Cohesionless Soils:**

1. Contains few fines (less than 5 percent fines).

### **D. Cohesionless Soils Containing Some Clay and Silt:**

1. Contains some clay and silt (between 5 percent fines and 15 percent plastic fines or 30 percent non-plastic fines).
2. Controlled by ASTM D7382.

## **2.04 MAXIMUM PARTICLE SIZE**

### **A. Soil for Compacted Backfill:**

1. Maximum particle size limitations described in appropriate Sections for compacted backfill against specific structures.

## **PART 3 EXECUTION**

### **3.01 SURFACE PREPARATION**

- A. Clear, grub, and strip.
- B. Prepare surface so that first compacted lift will be placed on firm, stable base. Perform proof-rolls to compact surface to specified compaction, if necessary.
- C. For water-retaining compacted fill, scarify and moisten surface to provide satisfactory bonding surface before placing layer of material to be compacted.

### **3.02 SOIL MOISTURE CONTENT**

- A. Moisten or aerate material, as necessary, to provide moisture content that will readily facilitate obtaining specified compaction. Add water to soil only in increments that will permit moisture content to be uniform and homogenous throughout each layer after mixing.
- B. Silty and Clayey Soils and Cohesionless Soils Containing Some Clay and Silt:
  - 1. Add no more than 2 percent water to fill by sprinkling just prior to compaction when fill is clayey and contains dry clods of clay:
    - a. If clayey borrow soil is more than 2 percent below optimum moisture, pre-conditioning and curing may be required to obtain uniform and homogenous distribution of moisture in the clods.
    - b. Use of disks, harrows, or rakes may be required to blend moisture in borrow area.
  - 2. Moisture content during compaction:
    - a. Soils controlled by impact compaction:
      - 1) Within 2 percent (wet or dry) of optimum moisture content.
    - b. Soils controlled by vibrating hammer:
      - 1) Within water content range for effective compaction as determined by ASTM D7382.
  - 3. Determine moisture as follows:
    - a. Soils controlled by impact compaction:
      - 1) Variation from Optimum Moisture Content:
        - a) Difference between optimum moisture and compaction moisture measured in accordance with ASTM D5080.
      - 2) Moisture Content Comparison:
        - a) Optimum moisture content determined by ASTM D698.

- b. Soils controlled by vibrating hammer:
  - 1) Within water content range for effective compaction as determined by ASTM D7382.
- c. Soils controlled by either impact compaction or vibrating hammer:
  - 1) Compare field compaction moisture content with moisture contents determined in accordance with:
    - a) ASTM D2216, or
    - b) ASTM D6938. Correct moisture from nuclear gage for gauge error for specific soils tested, moisture content of total material may require adjustment for control fraction (ASTM D4718).

C. Cohesionless Soils:

- 1. Add water during compaction, as necessary, since these soils are free-draining.

### 3.03 PLACEMENT

- A. Place soils to be compacted in horizontal layers.
- B. If necessary, blend materials so that compacted fill is homogenous and free from lenses, pockets, streaks, voids, laminations, or other imperfections.

### 3.04 COMPACTION

- A. For compacted backfill materials containing a maximum particle size exceeding 3-inches:
  - 1. Equipment:
    - a. Vibratory smooth drum rollers:
      - 1) Consisting of 2 drums in a suitable frame:
        - a) Drum width of not less than 4-feet or greater than 6-feet.
        - b) Each drum shall:
          - i. Have an outside diameter of not less than 3-feet.
          - ii. Be free to pivot about an axis parallel to direction of travel.
          - iii. Be capable of producing a minimum centrifugal force of 13,000-pounds at a frequency of vibration of 2,000 to 4,000 vibrations per minute.
      - 2) Minimum operating static weight of 20,000-pounds.
  - 2. Compact with vibrating smooth drum rollers, surface plate vibrator, or similar equipment:
    - a. Compact with 8 passes of equipment:

- 1) One pass of travel is full travel of entire length of compaction equipment in one direction over the compacted area.
  - b. Compact in horizontal layers to compacted thickness of 12-inches or less.
  - c. Offset each pass of the vibratory equipment so that the total compactive effort is distributed evenly over entire area. Do not have roller remain stationary on material zone with vibrating mechanism operating. Make roller passes in straight line to facilitate counting number of passes.
3. In areas where special compaction is required, compacted backfill material to have maximum particle size of 3-inches, and compaction is to be governed by requirements presented below.
- B. For materials containing a maximum particle size of less than 3-inches, compact material with the following methods and techniques appropriate to the type of soil.
1. Silty or Clayey Material:
    - a. Compact with mechanical impact tampers, tamping rollers, vibrating pad foot rollers, rubber tire rollers, other suitable compaction equipment, or equipment travel:
      - 1) Uniformly distribute equipment passes.
      - 2) Compact in horizontal layers to compacted thickness of 6-inches or less.
    - b. Special compaction: Compact with walk-behind roller, hand held impact tampers, or small tamping equipment:
      - 1) Uniformly distribute effort.
      - 2) Compact in horizontal layers to compacted thickness of 4-inches.
      - 3) Required within 3-feet horizontally of:
        - a) Structures.
        - b) Pipe.
        - c) Buried utilities.
    - c. Density:
      - 1) Percent Compaction:
        - a) Minimum: 98 percent beneath structures, extending away from bottom of structure at 1:1 slope.
        - b) Minimum: 95 percent.
      - 2) D-value:
        - a) Minimum: 98 percent beneath structures, extending away from bottom of structure at 1:1 slope.
        - b) Minimum: 95 percent.

2. Cohesionless Free-draining Material:
  - a. Compact with crawler-type tractors, vibrating drum rollers, surface plate vibrator, or similar equipment:
    - 1) Uniformly distribute equipment passes.
    - 2) Compact in horizontal layers to compacted thickness of 12-inches or less.
  - b. Special compaction: Compact with walk-behind vibrating roller, hand held impact tampers, vibrating plate tampers, or small tamping equipment:
    - 1) Uniformly distribute effort.
    - 2) Compact in horizontal layers to compacted thickness of 6-inches.
    - 3) Required within 3-feet horizontally of:
      - a) Structures.
      - b) Pipe.
      - c) Buried utilities.
  - c. Density:
    - 1) Percent Compaction:
      - a) Minimum: 98 percent beneath structures, extending away from bottom of structure at 1:1 slope.
      - b) Minimum: 95 percent.
3. Cohesionless Soils Containing Some Silt and Clay:
  - a. Compact in accordance with either procedure above.
  - b. Density:
    - 1) Percent Compaction:
      - a) Minimum: 98 percent beneath structures, extending away from bottom of structure at 1:1 slope.
      - b) Minimum: 95 percent.
4. Adjustment:
  - a. Silty and clayey soils containing more than 20 percent oversize particles: Required D ratio or Percent Compaction may be adjusted in accordance with appropriate curve on Figure 3 in USBR *Guidelines for Earthwork Construction Control Testing of Gravelly Soils*.
5. Demonstration:
  - a. Lift thicknesses may vary depending on equipment and methods. Before changing requirements in this Section, demonstrate that required density will be obtained.

### 3.05 MEASURE OF COMPACTION

- A. For compacted backfill materials containing a maximum particle size exceeding 3-inches:
  - 1. Demonstration of adequate compaction to be verified by COR.
- B. For materials containing a maximum particle size of less than 3-inches:
  - 1. Determine unit weight of soils in-place using one of the following methods:
    - a. Silty or clayey and cohesionless Soils:
      - 1) ASTM D1556, or
      - 2) ASTM D4914, or
      - 3) ASTM D5030, or
      - 4) ASTM D6938.
    - b. Cohesionless soil:
      - 1) ASTM D4564.
  - 2. Determine soil compaction by one of the following:
    - a. Silty or clayey soils:
      - 1) Percent Compaction:
        - a) Rapid Method: ASTM D5080.
        - b) Laboratory Compaction Test: Comparison of in-place density of minus no. 4 sieve size control fraction to laboratory maximum dry density as determined by ASTM D698, Procedure A.
    - b. Cohesionless soils:
      - 1) Percent Compaction:
        - a) In-place dry unit weight of minus 2-inch control fraction compared to the maximum dry unit weight determined by ASTM D7382.
    - c. Cohesionless soils containing some silt and clay:
      - 1) Using whichever testing procedure result requires higher in-place dry density.
  - 3. Adjustment
    - a. For soils containing 5 to 30 percent oversized particles:
      - 1) In-place unit weight of minus No. 4 size control fraction determined by screening gravel, washing, and determining mass and volume by assuming surface saturated dried moisture as outlined in ASTM D4718.

- b. For soils containing more than 30 percent oversized particles:
  - 1) Required D ratio or Percent Compaction may be adjusted in accordance with appropriate curve on Figure 3 in Reclamation Guidelines for Earthwork Control Testing of Gravelly Soils.

### 3.06 CONTRACTOR FIELD QUALITY TESTING

#### A. Testing:

1. Independent testing laboratory shall perform sampling, testing, and reporting as required in Table 31 23 02A - Contractor Materials Testing Requirements and Frequency:
  - a. Independent testing laboratory shall meet requirements specified in Section 01 46 20 – Testing Agency Services.
2. Notify independent testing laboratory and Government 24-hours before compaction work begins and 24-hours before significant change in compaction operations (major change in equipment or procedure used).
3. Notify independent testing laboratory and Government immediately of equipment change due to breakdown, or re-deployment.
4. Testing Frequency:
  - a. At minimum, perform test at frequencies specified in Table 31 23 02A - Contractor Materials Testing Requirements and Frequency.
  - b. Greater frequency of testing is normally performed at beginning of new work, new work crew, or new equipment.
  - c. After successful work operation pattern is established, testing frequency may be performed at minimum guidelines.
  - d. Perform additional tests at sites considered questionable by Government; such as suspected incomplete compaction, surfaces that may have become excessively wet or dry since compaction, compacted surfaces torn up by subsequent equipment travel, or other similar circumstances. Frequency of additional testing is at discretion of Government.

Table 31 23 02A - Contractor Materials Testing Requirements and Frequency

PROCEDURE	TEST STANDARD	STANDARD TITLE	MINIMUM FREQUENCY OF TESTING
Soil Classification	ASTM D2487	Classification of Soils for Engineering Purposes	As necessary to classify material to meet

Table 31 23 02A - Contractor Materials Testing Requirements and Frequency

PROCEDURE	TEST STANDARD	STANDARD TITLE	MINIMUM FREQUENCY OF TESTING
	ASTM D2488	Description and Identification of Soils	specification requirements or to index material for determining density by nuclear method.
Moisture Content	ASTM D2216	Laboratory Determination of Water (Moisture Content of Soil and Rock by Mass.	With in-place density or as required to index material for determining density by nuclear method.
Sand Cone	ASTM D1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method	Not less than 1 test per day per compacted backfill operation.
Rapid Construction Control	ASTM D5080	Rapid Determination of Percent Compaction	Not less than 1 test per day per compacted backfill operation
Laboratory Maximum Density	ASTM D 698, Procedure A	Laboratory Compaction Characteristics of Soil Using Standard Effort	Not less than 1 test per day per compacted backfill operation
Rock Factor	ASTM D4718	Correction of Unit Weight and Water Content for Soils Containing Oversize Particles	When oversize material is > 20 percent
Nuclear Method	ASTM D6938	In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)	Not less than 1 test per day per compacted backfill operation
Vibratory Hammer	ASTM D7382	Determination of Maximum Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibrating Hammer	Not less than 1 test per day per compacted backfill operation

**B. Contractor Support:**

1. Provide timely access to areas for density testing, excavate and level an area in compacted material to provide a surface for testing:
  - a. Test fills compacted by sheepsfoot rollers one or two lifts below surface.
2. Government may select location of testing.
3. When density is being measured by a sand-cone device ASTM D1556, cease construction activity in immediate vicinity of testing.
4. Dig test pits as requested to examine compacted soil against structures or pipe.
5. Replace compacted backfill within test pits to original requirements.
6. Provide warning lights, flags, or other safety devices as needed by testing personnel.
7. Provide adequate lighting for performing test if required because of darkness.

**3.07 FIELD QUALITY ASSURANCE**

- A. Government may perform test as required to verify contractor quality testing. If Government performs quality assurance testing, provide support as required for Contractor quality testing.

**END OF SECTION**

**SECTION 31 23 10**  
**EARTHWORK**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

**A. Common Excavation for Structures:**

1. Measurement: Made to excavation paylines shown on drawings or to paylines as directed by COR:
  - a. Regardless of quantities removed, measurement for payment will be made to prescribed paylines.
  - b. For safety or other reasons, Government reserves the right to require Contractor to excavate beyond prescribed paylines.
  - c. Measurement for payment for additional excavation will be made to limits as directed by COR.
2. Payment: Cubic yard prices offered in the Price Schedules:
  - a. Includes:
    - 1) Cost of labor and materials for pumping, unwatering, and dewatering.
    - 2) Shoring, sheeting, bracing, timbering, safety sloping and other temporary construction necessary to maintain excavations in good order during construction.
    - 3) Removing such temporary construction where required
    - 4) Stockpiling excavated material for compacted backfill
    - 5) Disposal of unused or wasted excavated materials.
  - b. Over-excavation performed beyond specified or directed paylines and compacted backfill for such over-excavation will be at expense of Contractor.

**B. Rock Excavation for Structures:**

1. Measurement: Made to excavation paylines shown on drawings or to paylines as directed by COR:
  - a. Regardless of quantities removed, measurement for payment will be made to prescribed paylines
  - b. For safety or other reasons, Government reserves the right to require Contractor to excavate beyond prescribed paylines.
  - c. Measurement for payment for additional excavation will be made to limits as directed by COR.

2. Payment: Cubic yard prices offered in Price Schedule 2 (Pumping Plant No. 7):
  - a. Includes:
    - 1) Cost of labor and materials for pumping and unwatering.
    - 2) Mechanical breaking, shoring, sheeting, bracing, timbering, safety sloping and other temporary construction necessary to maintain excavations in good order during construction.
    - 3) Removing such temporary construction where required.
    - 4) Stockpiling excavated material for compacted backfill
    - 5) Disposal of unused or wasted excavated materials.
  - b. Over-excavation performed beyond specified or directed paylines and compacted backfill for such over-excavation will be at expense of Contractor.

C. Compacted Backfill for Structures:

1. Measurement: Made to structure lines, excavation lines, and compacted backfill lines shown on drawings.
2. Payment: Cubic yard prices offered in the Price Schedules:
  - a. Includes cost of work associated with excavation or procuring, hauling and placement of necessary material:
    - 1) Material from required excavation used for compacted backfill will be paid for both as excavation when removed from original position and as compacted backfill when placed.
  - b. Where additional material is obtained from approved borrow pits and used for compacted backfill, payment will be made for compacted backfill only.
  - c. Replacement of materials where excavation is performed outside of established paylines will be at expense of Contractor.

D. Processing of Foundation Materials:

1. Measurement: Made to Foundation Excavation paylines shown on drawings.
2. Payment: Cubic yard price offered in the Price Schedules:
  - a. Includes cost of screening oversize materials after excavation of material, and before placement as compacted backfill.

Cost:

3. Include costs of excavation and compacted backfill in applicable prices offered in the Price Schedules for flowmeters, valves, chlorination system, and blowoff.
4. Include costs of excavation and compacted backfill for buried electrical items in prices offered in the Price Schedules for appropriate Division 26 Sections.
5. Include costs of excavation and compacted backfill for fencepost footings in items in prices offered in the Price Schedules for Chain Link Fence.

## 1.02 DEFINITIONS

- A. Additional Excavation: Excavation beyond specified lines as directed by COR to remove unsuitable foundation material.
- B. Over-excavation: Excavation performed for convenience, fault, or operation of Contractor beyond specified or directed additional excavation lines.
- C. Rock Excavation:
  - 1. Material that cannot be ripped with 400-horsepower or larger crawler tractor equipped with ripper rated for hard rock.
  - 2. Material that cannot be excavated with 300 horsepower or larger hydraulic excavator, with rock teeth, in areas where it is not feasible for ripping with a crawler tractor.
  - 3. Blasting is not permitted.
- D. Cover: Distance between top surfaces of buried cables, conductors, or conduits and finished grade.

## 1.03 REFERENCE STANDARDS

- A. ASTM International (ASTM)
  - 1. ASTM D4546-14 One-Dimensional Swell or Collapse of Cohesive Soils

## 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 23 10-1, Processing Plan:
  - 1. Describe equipment and methods for removing, stockpiling, processing, screening, moistening, placing, and compacting material to achieve the requirements in Parts 2.02 and 3.02.
  - 2. Provide schedule and sequence.
  - 3. Include working and stockpiling areas and haul route plans.
- C. RSN 31 23 10-2, Test Results:
  - 1. Swell potential test results in accordance with ASTM D4546.
  - 2. Include test date, time, location, person collecting soil samples, and correlating in-situ soil density and moisture information according to Section 31 23 02 – Compacting Earth Materials.

## **1.05 PROJECT CONDITIONS**

- A. Soil and rock conditions are described in Section 53 10 00 – Geologic Investigations:
  - 1. Expansive soils, as defined in Section 53 10 00 – Geologic Investigations, were encountered during investigations, but were located at depths below planned excavations. If claystone or other potentially expansive materials are encountered, COR should be notified immediately.
  - 2. Foundation soils encountered during investigations at depths of less than 10- to 15-feet contained substantial quantities of gravel and cobbles. It is expected that processing, consisting of screening and/or crushing, will be necessary to produce compacted backfill materials from on-site sources.

## **PART 2 PRODUCTS**

### **2.01 EXCAVATED MATERIALS**

- A. Contractor's operations in excavations shall be such that excavations will yield as much suitable material for use in permanent construction required under these specifications as practicable.
- B. Place excavated materials which are too wet for immediate compaction temporarily in stockpiles, and process until moisture content is reduced sufficiently to permit placement.

### **2.02 MATERIAL FOR COMPACTED BACKFILL**

- A. Type and amount of material used for compacted backfill, and manner of depositing material shall be subject to approval by COR.
- B. Obtain compacted backfill material from required excavations. If sufficient suitable material is not available from this source, obtain additional material from other sources approved by COR:
  - 1. Government makes no guarantee that specified compacted backfill materials are contained in or can be processed from materials excavated.
  - 2. All reasonable effort shall be expended to obtain suitable backfill material from required excavation prior to obtaining commercial sources.
- C. Do not use material removed during stripping for compacted backfill material.
- D. Do not use unprocessed expansive materials for compacted backfill material.
- E. Material gradation:
  - 1. Maximum particle size: 6-inch-diameter.
  - 2. Minimum of 50 percent particles passing the No. 4 sieve size, by weight.

- F. Compacted backfill within 2-inches of buried electrical grounding cables, insulated cables, and conduit: Sand or equally fine earth material.
- G. Where special compaction is required (in accordance with 31 23 02 – Compacting Earth Materials), compacted backfill is required to have a maximum particle size of 3-inches.
- H. All compacted backfill material shall be thoroughly mixed, evenly moistened, and have a swell potential of less than one percent under a load of 1,000 pounds per square foot.

## **PART 3 EXECUTION**

### **3.01 EXCAVATION, GENERAL**

- A. Excavate structure foundations to elevations shown on drawings or established by COR.
- B. Government reserves the right, during progress of work, to vary slopes, grades, and dimensions of excavations from those specified.
- C. Government does not represent that excavation performed under these specifications can be made to or maintained at paylines shown on the drawings or described in these specifications.
- D. Perform excavation in the dry.
- E. Do not excavate in frozen materials without written approval.
- F. Blasting: Not allowed.
- G. Preserve material below and beyond established lines of excavation in soundest possible condition:
  - 1. Damage to work due to Contractor's operations shall be repaired by and at expense of Contractor.
  - 2. Material beyond required or prescribed excavation lines which is loosened by Contractor's operations shall be removed at expense of Contractor.

### **3.02 OVER-EXCAVATION**

- A. If foundation material is excavated beyond lines required to receive structure, fill over-excavation with suitable materials and compact in accordance with Section 31 23 02 – Compacting Earth Materials.
- B. If foundation material is disturbed or loosened during excavation or otherwise, compact foundation in place or remove and replace it with suitable material and compact in accordance with Section 31 23 02 – Compacting Earth Materials.

### **3.03 PROCESSING AND STOCKPILING COMPACTED BACKFILL**

- A. Stockpile material in maximum 12-inch lifts as it is removed from excavation.
- B. Wet material as it is stockpiled to minimum of optimum moisture content.
- C. Test moisture content in accordance with Section 31 23 02 – Compacting Earth Materials.
- D. Excavated materials will require crushing, screening, and/or other processing to meet requirements of Article 2.02. Provide processing equipment and perform work necessary to process excavated materials to produce materials meeting requirements of these specifications.
- E. All compacted backfill material shall be thoroughly mixed and moistened to achieve uniform material and to avoid pockets or lenses of variable material.
- F. Earthwork equipment should be used to uniformly blend and moisture condition, aerate if necessary, stockpile material in order to achieve uniform fill material before it is placed as compacted backfill material.

### **3.04 SURFACES OF EXCAVATION**

- A. Vertical offsets within rock surfaces not to extend more than 2-inches, unless surfaces are to be covered with concrete or surfacing materials.

### **3.05 PREPARATION OF STRUCTURE FOUNDATIONS**

- A. Prepare foundations at structure sites by methods which will provide firm foundations for structures:
  - 1. Finish bottom and side slopes of excavation, upon or against which structure is to be placed, to prescribed dimensions.
  - 2. Moisten and compact prepared surfaces with suitable tools to form firm foundations upon or against which to place structure.
- B. Where unsuitable material is encountered in foundation for structure, COR will direct performance of additional excavation to remove unsuitable material:
  - 1. Replacement of materials where additional excavation is performed to be in accordance with Section 31 23 02 – Compacting Earth Materials.
- C. If potentially expansive materials (shale, claystone, mudstone, clay, etc.) are encountered, testing of swell potential of in-place material shall be performed, as directed by COR. Testing shall be in accordance with ASTM D4546:
  - 1. Take one test per 5,000 square feet per lift, or as directed by COR. Take a minimum of one test per day.

2. Swell Potential should be less than one percent under load of 1,000 pounds per square foot.
3. Surfaces of shale and/or claystone that are exposed by excavation to be kept moist until concrete, coarse aggregate, or earth material are placed on it. Test moisture content of foundation subgrade no more than 12-hours prior to placing concrete in accordance with 31 23 02 – Compacting Earth Materials.

### **3.06 FOUNDATION INSPECTION**

- A. Inspection will be performed by Government to obtain a geologic record of final foundation surface:
  1. Provide safe access for Government personnel during inspection.
  2. Notify COR at least 2-days before reaching final excavation elevation for foundation.
  3. Once an adequate foundation has been obtained, Government will require 2-days, to inspect, map and survey foundation:
    - a. Clean surface with straight edge of equipment bucket to expose foundation as directed by COR.
  4. Maintain prepared surfaces free of debris and standing water until inspection and geologic mapping are completed.
  5. Do not operate equipment in area being inspected until inspection and survey are complete.
  6. Verify that adequate compaction is achieved when compacting materials with particle sizes exceeding 3-inches (up to 6-inches), in accordance with 31 23 02 – Compacting Earth Materials.

### **3.07 DISPOSAL OF EXCAVATED MATERIALS**

- A. Dispose of excavated materials which are unsuitable for, or are in excess of compacted backfill or other earthwork requirements, as determined by COR, as provided in Section 31 23 39 – Disposal of Excavated Materials.

### **3.08 PLACING COMPACTED BACKFILL**

- A. Place compacted backfill to lines and grades shown on drawings, or as directed by COR.
- B. Place compacted backfill carefully and spread in uniform layers so that compacted backfill is homogeneous and free from lenses, pockets, voids, laminations, or other imperfections.
- C. Do not place compacted backfill material when either material or surfaces on which it is to be placed are frozen.

- D. Subsequent layers of compacted backfill may be placed as soon as compaction of previous layers is completed. Placing of additional materials may be delayed by COR at designated locations for procurement of samples for testing.

### **3.09 CONTRACTOR FIELD QUALITY TESTING**

- A. Notify COR within 48-hours of completion of excavation but before compaction. Do not compact until approved by COR.

### **3.10 COMPACTION**

- A. Place, moisten, and compact materials in compacted backfill as provided in Section 31 23 02 – Compacting Earth Materials:
  - 1. If potentially expansive materials are used in compacted backfill, average daily moisture content shall not be less than 1 percent wet of optimum beneath tanks or pumping plant structures.

### **3.11 PROTECTION**

- A. To provide adequate protection for compacted backfill around structure, Government reserves the right to direct Contractor to place sufficient amount of uncompacted backfill material over compacted backfill within 72-hours after compaction of compacted backfill.

### **3.12 TRENCHES FOR BURIED ELECTRICAL OR GROUNDING CABLES, INSULATED CABLES OR CONDUCTORS, AND CONDUIT**

- A. Refer to Division 26 – Electrical.

**END OF SECTION**

**SECTION 31 23 22**  
**PIPE TRENCH EARTHWORK**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Steel Manifold Piping and Line Pipe:
  - a. Includes:
    - 1) Common and Rock Excavation:
      - a) Cost of labor and materials for mechanical breaking, shoring, sheeting, bracing, timbering, safety sloping, and other temporary construction necessary to maintain excavations in good order during construction; of pumping and unwatering; of removing such temporary construction where required; stockpiling excavated material for backfill; and disposal of unused or wasted excavated materials.
    - 2) Backfill for Steel Manifold Pipe Trench and Line Pipe:
      - a) Cost of work associated with excavation or procuring, processing and hauling of necessary material.
      - b) Material from required excavation used for backfill in steel manifold and line pipe trenches will be paid for both as excavation when removed from original position and as backfill when placed.
      - c) Where backfill material is obtained from other sources, payment will be made for backfill only. Include cost of excavating or procuring, hauling, and processing of such material in prices offered in the Price Schedules for steel manifold piping and line pipe.
    - 3) Compacting Backfill in Steel Manifold Pipe and Line Pipe Trenches:
      - a) Volume of pipe will be deducted based on diameters shown on drawings, regardless of actual diameters of pipe furnished.
      - b) Includes cost of furnishing water and moistening material.



Table 31 23 22B – Reach 7\*

Station	Expected Springline Native Material Properties**
7395+50 to 7411+00	1
7395+00 to 7395+50 7411+00 to 7412+71	3

\*In case of differences between Table 31 23 22B – Reach 7 and actual conditions, actual conditions will govern.

In accordance with the clause at FAR 52.236-3 “Site Investigations and Conditions Affecting the Work”, Government assumes no responsibility for deductions, interpretations, or conclusions made by Contractor based on information made available in Table 31 23 22B – Reach 7.

\*\*Refer to Drawing 1695-D-60715 for explanation of Native Material Properties.

## **PART 2 PRODUCTS**

### **2.01 EXCAVATED MATERIALS**

- A. Contractor's operations in excavations shall be such that excavations will yield as much suitable material for use in permanent construction required under these specifications as practicable.
- B. Place excavated materials which are too wet for immediate compaction temporarily in stockpiles, and process until moisture content is reduced sufficiently to permit them to be placed.

### **2.02 BEDDING AND EMBEDMENT**

- A. Controlled low strength materials in accordance with Section 31 23 70 – Controlled Low Strength Materials (CLSM).

### **2.03 MATERIAL FOR COMPACTED BACKFILL**

- A. Type and amount of material used for compacted backfill, and manner of depositing material shall be subject to approval by COR.
- B. Obtain compacted backfill material from required excavations. If sufficient suitable material is not available from this source, obtain additional material from other sources approved by COR:
  1. Government makes no guarantee that specified backfill materials are contained in or can be processed from materials excavated from pipe trenches.
  2. All reasonable effort shall be expended to obtain suitable backfill material from required excavation prior to obtaining commercial sources.

- C. Do not use material removed during stripping for compacted backfill material.
- D. Do not use unprocessed expansive materials for backfill material.
- E. Material gradation:
  - 1. Maximum particle size: 6-inch-diameter.
  - 2. Minimum of 50-percent particles passing the No. 4 sieve size, by weight.
- F. Maximum particle size where special compaction is required (within 3-feet of pipes): 3-inches.
- G. Maximum particle size within 1-foot of outside of pipe: 3/4-inches.
- H. All compacted backfill material shall be thoroughly mixed, evenly moistened, and have swell potential of less than one percent under load of 1,000 pounds per square foot.

#### **2.04 WARNING TAPE:**

- A. Polyethylene tape.
- B. Thickness: 4 mils.
- C. Non-detectable.
- D. Width, minimum: 6-inches.
- E. Color: Blue with silver lettering.
- F. Legend repeated at least every 3-feet: “CAUTION: WATERLINE BURIED BELOW – FOR MORE INFORMATION CONTACT THE NAVAJO TRIBAL UTILITIES AUTHORITY”

### **PART 3 EXECUTION**

#### **3.01 GENERAL**

- A. Perform operations so that land can be restored to original conditions.
- B. Do not excavate pipe or keep pipe trench open more than 100-feet ahead of pipelaying, placement of compacted backfill, or compaction operations, unless approved by COR. Placement and compaction operations shall progress and not fall behind pipelaying and excavation operations, allowing for CLSM to obtain required strength shown on drawing 1695-D-60410. If placement and compaction of compacted backfill fall behind pipelaying operations, due to lack of progress or equipment breakdowns, stop excavation and pipelaying operations until sufficient progress has been made as directed by COR.

- C. Install warning tape over center of pipe, at least 18-inches below ground, and at least 18-inches above pipe.
- D. Locations:
  - 1. Areas designated on drawings for placement of steel manifold pipe.
  - 2. Areas designated on drawings for placement of drain pipes, foundation drain pipes, overflow drain pipes and sump drain pipes.

### **3.02 EXCAVATION**

- A. Excavate pipe trenches for pipelines and pipeline accessories to lines, grades, and dimensions shown on drawings.
- B. Government reserves the right, during progress of work, to vary slopes, grades, and dimensions of excavations from those specified.
- C. Government does not represent that excavation performed under these specifications can be made to or maintained at paylines shown on the drawings or described in these specifications.
- D. Perform excavation in the dry.
- E. Do not excavate in frozen materials without written approval of COR.
- F. Blasting: Not allowed.
- G. Preserve material below and beyond established lines of excavation in soundest possible condition:
  - 1. Damage to work due to Contractor's operations shall be repaired by and at expense of Contractor.
  - 2. Material beyond required or prescribed excavation lines which is loosened by Contractor's operations shall be removed at expense of Contractor.

### **3.03 OVER-EXCAVATION**

- A. When foundation material is over-excavated beyond specified or directed lines, fill over-excavation with backfill materials and compact in accordance with Section 31 23 02 – Compacting Earth Materials.
- B. If foundation material is over-excavated by being disturbed or loosened during excavation, compact material in place or remove and replace with backfill material and compact in accordance with Section 31 23 02 – Compacting Earth Materials.

### **3.04 PROCESSING AND STOCKPILING COMPACTED BACKFILL**

- A. Stockpile material in maximum 12-inch lifts as it is removed from excavation.

- B. Wet material as it is stockpiled to minimum of optimum moisture content.
- C. Test moisture content in accordance with Section 31 23 02 – Compacting Earth Materials.
- D. Excavated materials will require crushing, screening, and/or other processing to meet requirements of Article 2.0. Provide processing equipment and perform work necessary to process excavated materials to produce materials meeting requirements of these specifications.
- E. All compacted backfill material shall be thoroughly mixed and moistened to achieve uniform material and avoid pockets or lenses of variable material.
- F. Earthwork equipment should be used to uniformly blend and moisture condition, aerate if necessary, stockpile material in order to achieve uniform fill material before it is placed as compacted backfill material.

### **3.05 DISPOSAL OF EXCAVATED MATERIALS**

- A. Dispose of excavated materials which are unsuitable for or are in excess of compacted backfill or other earthwork requirements, as determined by COR, as provided in Section 31 23 39 - Disposal of Excavated Materials.

### **3.06 BEDDING AND EMBEDMENT**

- A. Place to lines shown on drawings or as directed by COR.
- B. Do not drop directly on pipe.
- C. Place CLSM in accordance with Section 31 23 70 – Controlled Low Strength Material (CLSM) and as shown on drawings.
- D. Place to widths and depths shown on drawings.
- E. Place at same elevation on both sides of pipe to prevent unequal loading and displacement of pipe. Elevation difference on sides of pipe shall not exceed 6-inches.

### **3.07 PLACING COMPACTED BACKFILL**

- A. Place compacted backfill in pipe trenches to lines shown on drawings, or as directed by COR.
- B. Do not drop compacted backfill material directly on pipe.
- C. Place compacted backfill carefully and spread in uniform layers so that compacted backfill is homogeneous and free from lenses, pockets, voids, laminations, or other imperfections.

- D. Do not place compacted backfill when either material or surfaces on which compacted backfill is to be placed are frozen.
- E. Subsequent layers of compacted backfill may be placed as soon as compaction of previous layers is completed. Placing of additional materials may be delayed by COR at designated locations for procurement of samples for testing.
- F. Place uncompacted backfill over pipe as approved by COR, if backfilling operations are interrupted for more than 24-hours.

### **3.08 COMPACTION**

- A. Compact backfill in pipe trenches in layers having about same top elevation on both sides of pipe to prevent unequal loading and displacement of pipe.
- B. Place, moisten, and compact materials in compacted backfill as provided in Section 31 23 02 – Compacting Earth Materials.
- C. Density:
  - 1. Percent Compaction, minimum 95 percent

### **3.09 PROTECTION**

- A. To provide adequate protection for compacted backfill in pipe trenches, Government reserves the right to direct Contractor to place sufficient amount of uncompacted backfill material over compacted backfill within 72-hours after compaction of compacted backfill.
- B. Place uncompacted backfill to minimum depth of 3-feet or compacted backfill to minimum depth of 2-feet above top of pipe before allowing construction equipment to travel over pipe:
  - 1. After these minimum earth covers are in place, maximum equipment loading allowed over pipe shall be HS-20 loading (16,000-pound wheel load) in accordance with AASHTO SSHB.
  - 2. If construction equipment that exerts a larger wheel load is proposed to be used, submit construction equipment loadings to COR for analysis and determination of required backfill depths or other protective measures.

**END OF SECTION**

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**SECTION 31 23 39**  
**DISPOSAL OF EXCAVATED MATERIALS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for items of work requiring excavation.

**1.02 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 31 23 39-1, Agreement and Permits:

1. Copy agreement with owner of land where unused excavated materials shall be placed.
2. Copy of Federal, State, Tribal, and local permits needed to place excavated materials.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 DISPOSAL OF EXCAVATED MATERIALS**

A. Waste material from required excavation which is not suitable or required for backfill, embedment, bedding, or topsoil to an approved location, as approved by COR:

1. Waste materials at an approved location off-site or on-site, as directed by COR:
  - a. Dispose of waste material within site boundaries unless prior approvals of cultural and environmental clearance have been obtained outside of site boundaries.
  - b. Do not place waste material in wetlands, within 12-feet of drainage channels, within 12-feet of edge of prescribed or actual cuts for laterals, wasteways, or drains.
  - c. Do not waste material by dumping from top of slope.
  - d.

- e. Grade waste banks to drain, with reasonably even and uniform surfaces that blend with natural terrain:
  - 1) Minimum slope: 2 percent.
  - 2) Maximum slope: 4H:1V.

**END OF SECTION**

**SECTION 31 23 50**  
**EARTHWORK FOR ROADS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Excavation for Roads:
1. Measurement:
    - a. Lines, grades, and dimensions shown on drawings or prescribed by COR.
  2. Payment:
    - a. Cubic yard prices offered in the Price Schedules. Includes cost of disposing of excavated materials.
  3. No payment will be made for excavation and replacement or refill of excavation beyond prescribed excavation lines.

**1.01 PROJECT CONDITIONS**

- B. Government may vary lines, grades, and dimensions of excavations from those shown on drawings based on actual materials and foundations encountered during excavation.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Clean fill materials in accordance with Section 31 23 02 – Compacting Earth Materials.
1. Maximum Particle Size: 6-inches.
  2. Source: Obtain and process materials from excavated materials or other sources, as approved by COR.

**PART 3 EXECUTION**

**3.01 EXCAVATION**

- A. Excavate to lines, grades, and dimensions shown on drawings or prescribed by COR.
- B. Excavate in dry conditions.

**3.02 PREPARATION**

- A. Grade and prepare subgrade free from depressions and soft spots:

1. Additional excavation required for soft soils as directed by COR. Replace with compacted backfill in accordance with 31 23 02 – Compacting Earth Materials.
- B. Obtain Government approval of subgrade before placing surfacing.

### **3.03 OVER-EXCAVATION AND ADDITIONAL EXCAVATION**

- A. Preserve materials below and beyond prescribed excavation lines in soundest possible condition. Repair damage to work caused by construction operations.
- B. Refill excavation beyond prescribed excavation lines with compacted backfill in accordance with Section 31 23 02 – Compacting Earth Materials.
- C. Remove foundation material adjacent to excavation which is disturbed or loosened during excavation operations or other work.

### **3.04 PROTECTION**

- A. Provide temporary construction, pumping, bailing, draining, shoring, sheeting, bracing, and other work necessary to maintain excavations during construction operations.

### **3.05 DISPOSAL**

- A. Use suitable excavated materials for required backfill. Locations and procedures for stockpiling will be subject to approval by COR.
- B. Dispose of excavated materials which are not used or suitable for backfill in accordance with 31 23 39 – Disposal of Excavated Materials.

### **3.06 PLACING**

- A. Placing and Compacting:
1. Place in layers and compact in accordance with Section 31 23 02 – Compacting Earth Materials.

**END OF SECTION**

**SECTION 31 23 70**  
**CONTROLLED LOW STRENGTH MATERIALS (CLSM)**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. Include in prices offered in the Price Schedules for Steel Manifold Piping and Line Pipe:
  - a. Bedding Zone.
  - b. Embedment Zone.
  - c. All other including road and utility crossing requirements.

B. Cost:

1. Include in prices offered in the Price Schedules for Steel Manifold Piping and Line Pipe at utility crossings and other locations as shown on drawings.

**1.02 REFERENCE STANDARDS**

A. American Concrete Institute (ACI)

- |    |            |  |
|----|------------|--|
| 1. | ACI 318-14 | Building Code Requirements for Structural Concrete |
|----|------------|--|

B. ASTM International (ASTM)

- |    |                      |   |
|----|----------------------|---|
| 1. | ASTM C33/C33M-16e1   | Concrete Aggregate  |
| 2. | ASTM C94/C94M-17a    | Ready-Mixed Concrete  |
| 3. | ASTM C114-15         | Chemical Analysis of Hydraulic Cement                                 |
| 4. | ASTM C143/C143M-15a  | Slump of Hydraulic-Cement Concrete                                    |
| 5. | ASTM C150/C150M-17   | Portland Cement   |
| 6. | ASTM C618-17a        | Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| 7. | ASTM C1602/C1602M-12 | Mixing Water Used in the Production of Hydraulic Cement Concrete      |
| 8. | ASTM D4318-17        | Liquid Limit, Plastic Limit and Plasticity Index of Soils             |
| 9. | ASTM D1558-10        | Moisture Content Penetration Resistance of Fine-Grained Soils         |

- |     |               |   |
|-----|---------------|---|
| 10. | ASTM D4832-16 | Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders               |
| 11. | ASTM D6024-16 | Ball Drop on Control Low Strength material (CLSM) to determine Suitability for Load Application |

### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 23 70-1, Approval Data for CLSM Produced without Native Soil:
  - 1. Mix Design: For each CLSM mix:
    - a. Mixture proportions.
    - b. Material sources:
      - 1) Name and manufacturer of each cementitious material.
      - 2) Name of aggregate sources.
      - 3) Product name and manufacturer of admixtures to be used in mix.
      - 4) Government reserves right to require submission of samples of CLSM materials for testing before or during use in concrete.
    - c. If proposed material has more than 30 percent passing 200 sieve, provide mix designs for:
      - 1) 10 to 30 passing 200 sieve.
      - 2) 30 to 50 passing 200 sieve.
    - d. Physical properties:
      - 1) Trial mixtures:
        - a) Results from trial batches made within past 6-months.
        - b) Trial mix test results, three 6-inch-diameter cylinders, each at 7- and 28-days.
        - c) Average compressive strength of trial batch cylinders at specified design age.
    - e. Resubmit mix design for change in material source or type.
    - f. Cementitious materials manufacturer's certifications and test reports within last 6-months.
    - g. Aggregate test reports for gradation and plasticity, less than 6-months old.
    - h. Method to determine moisture and consistency of materials to maintain specified strengths. Provide testing frequency.

2. NRMCA Certification of Production Facilities:
    - a. Automatic digital recording of cementitious materials, aggregate, water, and chemical admixtures.
    - b. Verification that facility meets requirements for furnishing concrete in subfreezing weather.
    - c. ACI Personnel Certification(s):
      - 1) Aggregate Testing Technician.
      - 2) Concrete Field Testing Technician.
      - 3) Concrete Strength Testing Technician.
  3. Current calibration of scales, water meters, and admixture dispensers.
  4. If Quality Control test results show CLSM does not meet requirements, submit revised mix design.
- C. RSN 31 23 70-2, Approval Data for CLSM Produced with Native Soil:
1. Submit Mix design for each material type:
    - a. If proposed material has more than 30 percent passing 200 sieve, provide mix designs for:
      - 1) 10 to 30 percent passing 200 sieve.
      - 2) 30 to 50 percent passing 200 sieve.
    - b. Physical properties:
      - 1) Trial mixtures:
        - a) Results from trial batches made within past 6-months.
        - b) Trial mix test results, three 6-inch-diameter cylinders, each at 7- and 28-days.
        - c) Average compressive strength of trial batch cylinders at specified design age.
    - c. Resubmit mix design for change in material source or type.
    - d. Cementitious materials manufacturer's certifications and test reports within the last 6-months:
    - e. Material test reports for gradation and plasticity, less than 6-months old:
  2. Soil processing and mixing equipment.
  3. Foreman references.
  4. Method to maintain specified strengths using native soils.
  5. If quality control test results show CLSM does not meet specified requirements, submit revised mix design.

- D. RSN 31 23 70-3, Quality Control Test Results:
1. Notify COR within 2-hours if testing does not meet specified requirements.
  2. If Quality Control Test Results show CLSM does not meet specified requirements, submit a revised mix design.

#### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. CLSM delivered from ready mix plants, furnish complete and legible batch ticket with each batch of CLSM in accordance with ASTM C94. Deliver ticket to COR at jobsite during batch delivery.

#### **1.05 QUALIFICATIONS**

- A. References for foreman in charge of CLSM placement, if CLSM is produced with native soils: Three projects within last 3-years.

### **PART 2 PRODUCTS**

#### **2.01 BACKFILL FOR PIPE TRENCHES**

- A. See Section 31 23 22 – Pipe Trench Earthwork.

#### **2.02 STEEL PIPE**

- A. See Section 35 21 95 – Steel Manifold Piping.

#### **2.03 CEMENTITIOUS MATERIALS**

- A. Cement and pozzolan shipments shall be accompanied by shipping documents containing:
1. Manufactures Certification that material meets requirements.
  2. Type or class of material shipped.
  3. Manufacturing locations and dates.
  4. Lot (bin) number.
  5. Date of shipment.
  6. Quantity of material shipped.
  7. Provide to COR.
- B. Cementitious Materials Options:
1. Specified portland cement plus 20 to 80 percent by weight of total cementitious (cement plus pozzolan) specified pozzolan, in accordance with ACI 318.

C. Portland Cement:

1. ASTM C150, Type V.
2. Meet equivalent alkalis requirements of ASTM C150, Table 2.
3. Meet false-set requirements of ASTM C150, Table 4.

D. Pozzolan:

1. ASTM C618, Class F, except,
  - a. Sulfur trioxide for Class F, maximum: 4.0 percent.
  - b. Loss on ignition, maximum: 2.5 percent.
  - c. Test for effectiveness in controlling alkali-silica reaction under optional physical requirements in Table 2 of ASTM C618. Use low-alkali cement for test.
  - d. Does not decrease sulfate resistance of CLSM by use of pozzolan:
    - 1) Demonstrate pozzolan will have an "R" factor less than 2.5.
    - 2)  $R = (C-5)/F$ .
    - 3) C: Calcium oxide content of pozzolan in percent determined in accordance with ASTM C114.
    - 4) F: Ferric oxide content of pozzolan in percent determined in accordance with ASTM C114.

## 2.04 WATER

- A. ASTM C1602.

## 2.05 AGGREGATE OR SOIL

A. Aggregate:

1. ASTM C33.
2. Maximum particle size: 3/8-inch.

B. Soil:

1. PI: Less than 10. LL: Maximum of 30.
2. Gradation:
  - a. Passing U.S. Standard No. 200 sieve, by weight, maximum: 50 percent.
  - b. Passing U.S. Standard No. 100 sieve, by weigh, maximum: 70 percent.
  - c. Maximum particle size: 3/8-inch.
3. Select or process soil so that particles remain in suspension, i.e., no segregation occurs, when CLSM is placed.

4. Clay balls:
  - a. Maximum percent, by weight of soil: 10 percent.
  - b. Maximum size: 3/8-inch.

## **2.06 MIX**

- A. Mixture of Aggregate or Soil, Cementitious Materials, Water, and Admixtures:
  1. Cementitious material content: Percent by dry weight of aggregate or soil to obtain specified compressive strength.
  2. Make trial mixes prior to placing CLSM to determine mixture adequacy:
    - a. Determine compressive strength in accordance with ASTM D4832.
    - b. Determine slump in accordance with ASTM C143.
- B. Water Content: Not to exceed that required to provide mix that will flow and can be pumped.
- C. Seven-day Compressive Strength, ASTM D4832: Not less than 50 pounds per square inch (lb/in<sup>2</sup>) and not more than 150 lb/in<sup>2</sup>.
- D. Consistency:
  1. Except, when a stiffer mix required to prevent CLSM from flowing down trenches on a steep slope:
    - a. Slump, ASTM C143: 8- to 10-inches.

## **2.07 CLSM TEMPERATURE**

- A. CLSM Temperature at time of placement: 50 to 85 degrees F (10 to 30 degrees C).

## **PART 3 EXECUTION**

### **3.01 BATCHING EQUIPMENT**

- A. Design and Operation of Mixers: Discharged CLSM shall be uniform in composition and consistency throughout each batch:
  1. Adjust amount of water and aggregates batched for CLSM to compensate for variations in moisture content or grading of aggregates as they enter mixer.
  2. Inform COR prior to and after adjustments in batching equipment and control instrumentation.
  3. Equip truck mixer with dial or digital water meter accurate to within 1 percent of total mix water located between water supply and mixer.

4. Provide revolution counter which indicates total number of revolutions of drum per batch:
    - a. Visible from outside truck.
    - b. Reset to zero for each batch.
  5. Attach metal plate attached in a prominent place on mixer listing:
    - a. Manufacturer's recommended drum capacity.
    - b. Mixing and agitating speeds in accordance with ASTM C94.
  6. Initial Mixing: Not less than 70 revolutions and not more than 100 revolutions after ingredients are in drum.
  7. Mix 30 revolutions after addition of tempering water.
  8. Mix 10 to 12 revolutions after prolonged period of agitation.
  9. Discharge CLSM before 300 drum revolutions.
- B. Manufacture and deliver in accordance with ASTM C94:
1. In addition to requirements of ASTM C94, use water meter approved by COR to measure and record mix water for each batch.
- C. Provide following information to COR:
1. Copy of current calibration of scales and water meters.
  2. Mix water information.

### **3.02 TRIAL BATCH**

- A. Perform trial run with proposed equipment and material prior to placing CLSM:
1. Obtain Representative Sample of Material:
    - a. If native soil materials are used, mix material from top of trench to proposed invert:
      - 1) Discard material not meeting requirements.
    - b. Test material for gradation, plasticity.
  2. Test CLSM for slump and compressive strength:
    - a. Prepare and test three 6- by 12-inch cylinders for both 7- and 28-day according to ASTM D4832.

### **3.03 PREPARATION**

- A. Place pipe on soil pads or other approved compressible material such as extruded polystyrene foam insulation. Soil pads shall maintain horizontal and vertical alignment during backfilling operations:
1. Do not create point loads on pipe:
    - a. Soil pads shall have lower compressible strength than surrounding CLSM.

### **3.04 PLACING**

- A. Notify COR at least 24-hours before batching CLSM. Include quantity of CLSM required for each daily placement. Unless inspection is waived, perform batching in presence of Government inspector.
- B. Do not place CLSM during rain.
- C. Do not mix or place CLSM when ambient temperature is below 40 degrees F. Except when, ambient temperature is 35 degrees F and rising and daily high is predicted to be above 40 degrees F, CLSM may be placed, if approved by COR.
- D. Place CLSM to lines, grade, and dimensions shown on drawings:
  - 1. Initially, place CLSM from 1 side of pipe. Where necessary, rod or vibrate CLSM so that CLSM flows under pipe and appears on other side.
  - 2. Add CLSM to both sides of pipe and rod or vibrate until CLSM completely fills space between pipe and trench.
  - 3. Do not disturb pipe trench or allow foreign material to become mixed with CLSM.
- E. Restrain pipe to prevent flotation during placement of CLSM:
  - 1. Do not point load pipe.
- F. Do not place backfill material over CLSM until CLSM has reached initial set:
  - 1. As determined by ASTM D6024 (ball drop test) or ASTM D1558 in presence of COR.
  - 2. Do not place greater than 10-feet of backfill over pipe until CLSM has compressive strength of 50 lb/in<sup>2</sup> or greater.

### **3.05 CONTRACTOR FIELD QUALITY TESTING**

- A. Testing:
  - 1. Independent testing laboratory shall perform sampling, testing, and reporting:
    - a. Independent testing laboratory shall meet requirements specified in Section 01 46 20 – Testing Agency Services.
    - b. Government may inspect testing laboratory facilities. COR will notify testing facilities 72-hours before inspection. Periodic inspection may be required by COR.
  - 2. If CLSM Contains Native Soils:
    - a. Obtain and test soil samples for gradation and plasticity daily while batching and placing CLSM or if change in soil is visually noted:
      - 1) Test material 14-days ahead of placement from top of trench to proposed invert.

- b. During CLSM batching, provide an inspector from testing laboratory to monitor soil characteristics and operations:
  - 1) Modify material and or batching operations as recommended by testing laboratory.
  - 2) Notify COR within 24-hours of modifications.
- 3. Obtain samples and test to determine compressive strength in accordance with ASTM D4832 and slump in accordance with ASTM C143:
  - a. Testing frequency:
    - 1) At least once for each shift when placing CLSM.
    - 2) Once every 100 cubic yards or,
    - 3) If consistency of materials change.
  - b. Acceptance Criteria:
    - 1) 7-day compressive strength, ASTM D4832:
      - a) Not less than 50 lb/in<sup>2</sup> and not more than 150 lb/in<sup>2</sup>.
      - b) 70 percent of test cylinders shall exceed 75lb/in<sup>2</sup>.
  - c. Make adjustments to mixture to comply with strength requirements.
  - d. Stop work if specified requirements are not met.

### **3.06 FIELD QUALITY ASSURANCE**

- A. Government may obtain samples and test for compressive strength in accordance with ASTM D4832 and slump in accordance with ASTM C143.

### **3.07 PROTECTION**

- A. When subsequent lifts of CLSM are to be placed, maintain surface of CLSM in moist condition by use of tarps or water mist until subsequent lift of CLSM is placed.
- B. If backfill will not be placed over CLSM within 8-hours, place 6-inch minimum cover of moist backfill over CLSM. Maintain moisture in 6-inch soil cover until additional backfill is placed.
- C. If ambient temperature is forecast to be 50 degrees F or less within 8-hours of placing CLSM, place 12-inch minimum additional cover of loose backfill over 6-inch moist backfill cover before end of work day. Do not allow CLSM to freeze.

**END OF SECTION**

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**SECTION 31 24 18**  
**GRAVEL DRAIN FOR ~~CONCRETE~~-WATER STORAGE TANKS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Gravel Drain Material for *Water Storage Tanks*:
1. Measurement: Volume in place to lines, grades, and dimensions shown on drawings or as directed by COR. No allowance will be made for shrinkage, settlement, or consolidation.
  2. Payment: Cubic yard price offered in the Price Schedules:
    - a. Includes gravel drain material for ditch and trough lining.
    - b. Includes cost of compacting gravel drain material.

**1.02 REFERENCE STANDARDS**

- A. ASTM International (ASTM)
- |    |                    |  |
|----|--------------------|--|
| 1. | ASTM C88-13        | Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate                                      |
| 2. | ASTM C123/C123M-14 | Lightweight Particles in Aggregate   |
| 3. | ASTM C127-15       | Relative Density (Specific Gravity) and Absorption of Coarse Aggregate                                     |
| 4. | ASTM C131/C131M-14 | Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| 5. | ASTM C142/C142M-10 | Clay Lumps and Friable Particles in Aggregates   |
| 6. | ASTM D4318-10      | Liquid Limit, Plastic Limit, and Plasticity Index of Soils   |

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 24 18-1, Laboratory Test Results:
1. Laboratory test results demonstrating gravel drain material meets Table 31 24 18A – Gravel Drain Material Gradation and Table 31 24 18B – Gravel Drain Material Requirements.

## PART 2 PRODUCTS

### 2.01 GRAVEL DRAIN MATERIAL

- A. Provide from commercial source.
- B. Meet requirements specified in Table 31 24 18A – Gravel Drain Material Gradation and Table 31 24 18B – Gravel Drain Material Requirements.

Table 31 24 18A – Gravel Drain Material Gradation

U.S. Standard Sieve Size	Percent Passing by Weight
1/2-inch	100
3/8-inch	90 – 100
No. 4	20 – 55
No. 8	5 – 30
No. 16	0 – 10
No. 50	0 – 5

Table 31 24 18B – Gravel Drain Material Requirements

Item	Requirement	Reference Standard
Material passing No. 40 sieve	Non Plastic	ASTM D4318
Specific Gravity	Minimum 2.60	ASTM C127
Clay lumps and Friable Particles	Less than 1.0 percent by weight	ASTM C142
Lose due to Sodium Sulfate Soundness	Less than 10 percent	ASTM C88
Lose due to LA Abrasion	Less than 50 percent	ASTM C131
Chert	Less than 1.0 percent by weight	ASTM C123
Coal and Lignite	Less than 1.0 percent by weight	ASTM C123

- C. Limestone or crushed/recycled concrete material sources are not allowed.
- D. Material shall meet specified gradation requirements after fill placement and compaction.

## PART 3 EXECUTION

### 3.01 COMPACTION EQUIPMENT

- A. Walk-behind vibrating roller or tamper will be required for compaction of gravel drain material.

**3.02 PREPARATION OF FOUNDATION**

- A. Control water in all excavations before placing materials in accordance with Section 31 03 33 – Removal of Water from Excavation.
- B. Conform to applicable requirements of Section 31 23 02 – Compacting Earth Materials.

**3.03 MOISTURE CONTROL**

- A. Conform to applicable requirements of Section 31 23 02 – Compacting Earth Materials.

**3.04 PLACING**

- A. Place in continuous, approximately horizontal layers not to exceed 6-inches in thickness after compaction.
- B. Thoroughly wet gravel drain material immediately before compaction.
- C. Place material to lines, grades, and dimensions as shown on drawings.
- D. Minimize persons working on gravel drain material to prevent segregation, contamination, or breakdown of materials.
- E. Control sloughing of any materials from excavated surfaces onto gravel drain material to minimize contamination.

**3.05 REQUIRED COMPACTION**

- A. Compact with four passes of walk-behind vibrating roller or tamper as approved by COR. Compact in horizontal layers to compacted thickness of 6-inches.
- B. Uniformly distribute effort.
- C. Use caution when compacting gravel drain material within 2-feet adjacent to pipes.

**3.06 PROTECTION**

- A. Protect material from erosion, contamination, excessive saturation, freezing, and surface drainage.

**3.07 FIELD QUALITY ASSURANCE**

- A. Contractor shall perform one test for every 6-inch layer (minimum of two tests total) to verify that gravel drain material meets gradation requirements in Table 31 24 18A – Gravel Drain Material Gradation after compaction. Sample locations will be determined by COR.

**END OF SECTION**

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**SECTION 31 31 30**  
**SOIL-APPLIED HERBICIDE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedule for other items of work.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 31 30-1, Use Plan.
- C. RSN 31 31 30-2, Applicator Certification.

**1.03 QUALIFICATIONS**

- A. Applicators: Certified by appropriate State or local agencies, as required.

**1.04 REGULATORY REQUIREMENTS**

- A. Comply with label directions, and applicable EPA, State, and local laws and regulations.

**PART 2 PRODUCTS**

**2.01 HERBICIDES**

- A. Label: EPA (Environmental Protection Agency) pesticide registration number.
- B. Provide soil-applied herbicide conforming to one of the following:
- C. Atrazine:
1. Composed of a finely divided, wettable powder containing a minimum of 80 percent chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine and related compounds.
  2. Mix: Minimum of 2-gallons of water per pound of dry product.
- D. Bromacil:
1. Composed of a finely divided, wettable powder containing a minimum of 80 percent bromo-3-sec-butyl-6-methyluracil.
  2. Mix: Minimum of 2-gallons of water per pound of dry product.

- E. Prometon:
  - 1. Composed of a liquid emulsifiable solution containing a minimum of 25 percent 2-methoxy-4, 6-bis isopropylamino-s-triazine.
  - 2. Mix with water:
    - a. For small areas, add sufficient water to provide thorough and uniform coverage.
    - b. For large areas, add concentrate to 100 gallons of water per acre.
- F. Commercial mixtures meeting requirements may be used.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Apply herbicide after gravel surfacing has been placed.

### **3.02 APPLICATION**

- A. Apply herbicide to gravel surfacing placed under these specifications:
  - 1. Select one herbicide from those specified.
  - 2. Apply soil-applied herbicide at following rate:
    - a. Atrazine: Equivalent of 0.035 pound of dry product per 100 square feet (about 15 pounds per acre).
    - b. Bromacil: Equivalent of 0.035 pound of dry product per 100 square feet (about 15 pounds per acre).
    - c. Prometone: Equivalent of 0.017 gallon of herbicide concentrate per 100 square feet (about 7 1/2-gallons per acre).
- B. Apply herbicide only with approval of COR.
- C. Apply uniformly.
- D. During application, continuously agitate suspension.

**END OF SECTION**

**SECTION 31 32 36**  
**HDPE GEOMEMBRANE FOR CONCRETE ~~AND BOLTED STEEL~~**  
**WATER STORAGE TANKS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. HDPE Geomembrane for ~~Concrete Tank and Bolted Steel Tank Options~~ Water Storage Tanks:

1. Measurement: Surface area required to be covered including geomembrane placed in anchor trench except no allowance will be made for seam overlap, repairs, or waste.
2. Payment: Square yard price offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |     |                      |  |
|-----|----------------------|--|
| 1.  | ASTM D792-13         | Density and Specific Gravity (Relative Density) of Plastics by Displacement  |
| 2.  | ASTM D1004-13        | Tear Resistance (Graves Tear) of Plastic Film and Sheeting   |
| 3.  | ASTM D1505-10        | Density of Plastics by the Density-Gradient Technique  |
| 4.  | ASTM D1603-14        | Carbon Black in Olefin Plastics  |
| 5.  | ASTM D3895-14        | Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry   |
| 6.  | ASTM D4437-08 (2013) | Non-Destructive Testing (NDT) for Determining the Integrity of Seams used in Joining Flexible Polymeric Sheet Geomembranes |
| 7.  | ASTM D4833-07 (2013) | Index Puncture Resistance of Geomembranes and Related Products   |
| 8.  | ASTM D5323-92 (2011) | Determination of 2% Secant Modulus for Polyethylene Geomembranes   |
| 9.  | ASTM D5397 (2012)    | Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test                  |
| 10. | ASTM D5596-03 (2016) | Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics                                       |

- |      |  |   |
|------|--|---|
| 11.  | ASTM D5617-04 (2015)                             | Multi-Axial Tension Test for Geosynthetics  |
| 12.  | ASTM D5721-08(2013)                              | Air-Oven Aging of Polyolefin Geomembranes   |
| 13.  | ASTM D5885-15                                    | Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry                           |
| 14.  | ASTM D5994-10 (2015)                             | Measuring Core Thickness of Textured Geomembrane  |
| 15.  | ASTM D6497-02 (2015)                             | Mechanical Attachment of Geomembrane to Penetrations or Structures  |
| 16.  | ASTM D6693-04 (2015)                             | Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes                            |
| 17.  | ASTM D6706                                       | Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil  |
| 18.  | ASTM D7238-06 (2012)                             | Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus                             |
| 19.  | ASTM D7466-10 (2015)                             | Asperity Height of Textured Geomembrane   |
| <br> |  |   |
| B.   | Geosynthetics Research Institute Standards (GRI) |   |
| 1.   | GRI GM-6 – 1994                                  | Pressurized Air Channel Test for Dual Seamed Geomembranes   |
| 2.   | GRI GM 12 – 1998                                 | Asperity Measurement of Textured Geomembranes Using a Depth Gage  |
| 3.   | GRI GM 13  | Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes |
| 4.   | GRI GM 19 – 2005                                 | Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane   |

### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 31 32 36-1, Certification:
1. Manufacturer's certification that resin used in manufacture of HDPE geomembrane being furnished meets requirements of these specifications.
  2. Copies of quality control certificates issued by resin supplier.

3. Certified test results of physical properties tests listed in Table 31 32 36A – HDPE Geomembrane Physical Properties. Submit test results at frequency specified in GRI GM 13. Identify with production date, roll goods number, and quantity represented.
4. Certification that the HDPE geomembrane and the extrusion welding rod or pellets produced for use under this contract have the same properties and are compatible.
5. Qualifications:
  - a. Installation company:
    - 1) Name and address
    - 2) Documentation of previous experience with specified geomembrane:
      - a) Names of facility owner(s).
      - b) Person to contact at facilities who can discuss projects listed.
      - c) Project manager, designer, manufacturer, fabricator (if any).
      - d) Locations, thicknesses, and area in square feet of geomembrane installed.
      - e) Types of seaming and patching equipment used.
      - f) Dates of installation.
    - 3) Onsite personnel experience:
      - a) Resumes, including dates and duration of employment and pertinent experience.
  - b. Manufacturer:
    - 1) Name and address of geomembrane manufacturer.
    - 2) Name and address of panel fabricator, if different from manufacturer.
    - 3) Name and address of manufacturer's technical representative(s), including resume(s), including dates and duration of employment and pertinent experience.
    - 4) Evidence of manufacturer experience:
      - a) Name, location, owner, and purpose of completed facility.
      - b) Name and telephone number of contact at facility who can discuss project.

- c) Geomembrane type and thicknesses, total square footage of installation, installation date, project manager, designer, fabricator (if any), and installer.
    - 5) Descriptive documentation of manufacturer's quality control program.
  - 6. Manufacturer's instructions for delivery, storage, and handling of geomembrane materials.
  - 7. Details of geomembrane installation:
    - a. Work schedule.
    - b. Panel Layout:
      - 1) Location, size, orientation, and identification of panels and continuous seams.
    - c. Sequencing of panel installation.
    - d. Equipment and procedures for:
      - 1) Handling and installing panels.
      - 2) Continuous seaming.
      - 3) Geomembrane boots around penetrations.
      - 4) Field testing adequacy of seaming equipment and seams.
      - 5) Geomembrane attachment to concrete structures.
      - 6) Cleaning, protecting, and repairing geomembrane and seams.
      - 7) Wrinkle management.
    - e. Number of crews and crew size.
    - f. Contractors Quality Control (QC) Plan.
    - g. Placement method.
- C. RSN 31 32 36-2, Pre-Construction:
  - 1. Lot and roll numbers.
  - 2. Manufacturer QC data for rolls to be shipped.
  - 3. Manufacturer's data and certifications for resin and weld rod.
  - 4. Manufacturer's Warranty.
- D. RSN 31 32 36-3, Construction:
  - 1. Quality Control Tests.
  - 2. Surveyed panel layout drawings.
  - 3. Locations of patches, repairs, and destructive samples.

4. Deviations from panel layout drawings submitted as part of geomembrane installation plan.

#### **1.04 QUALIFICATIONS**

- A. Onsite Geomembrane Installation Supervisor:
  1. Installed or supervised installation and seaming of a minimum of 1,000,000 square feet of specified geomembrane.
- B. Onsite Geomembrane Master Welder (Seamer):
  1. Within last 5-years, completed a minimum of 500,000 square feet of specified geomembrane seaming work using type of seaming apparatus proposed for use on this project. Master welder (seamer) may also be installation supervisor/field engineer.
- C. Other Onsite Geomembrane Welders (Seamers):
  1. Within last 3-years, seamed a minimum of 100,000 square feet of specified geomembrane.
- D. Geomembrane Manufacturer:
  1. Completed facilities totaling at least 2,000,000 square feet of specified geomembrane.
- E. Installer:
  1. At least three separate and satisfactory installations totaling at least 1,000,000 square feet of the specified geomembrane.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Ship, handle, store, and care for geomembrane in accordance with manufacturer's instructions.
- B. Pack geomembrane rolls and panels in snug-fitting containers having smooth, abrasive-free interior to prevent damage to geomembrane during transit and handling:
  1. Use containers having structurally sound bottoms designed for lifting with forklift-type trucks or approved cables or slings.
  2. Mark each container of geomembrane panels with name of material, approved roll good numbers, specifications number, quantity contained, name of Contractor, and order or purchase number.
- C. Do not stack rolls more than 3 rolls high.
- D. Cover rolls of geomembrane with tarp if onsite for more than 30-days.

- E. Protect geomembrane rolls from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or cold, direct sunlight or other damage.

## **1.06 PROJECT ENVIRONMENTAL REQUIREMENTS**

- A. Do not perform field seaming when geomembrane is wet or when wind is displacing geomembrane panels.
- B. Seam only when air temperature is above 35 degrees F and below 104 degrees F.
- C. Expect wind and extreme temperature variations.

## **1.07 WARRANTY**

- A. Provide manufacturer's warranty that HDPE geomembrane material is free of defects or failure for a period of 20-years.

## **PART 2 PRODUCTS**

### **2.01 HDPE GEOMEMBRANE**

- A. HDPE Geomembrane:
  - 1. 80-mil HDPE (High Density Polyethylene) Double Textured (textured on both sides) meeting requirements of GRI GM 13.
  - 2. Stabilizers and biocides: Impart durability.
  - 3. Pigment:
    - a. Carbon black to produce opaque film ranging from dark gray to black in color.
    - b. Disperse carbon black evenly to produce a uniform color.
  - 4. Finish: Textured on both sides.
  - 5. Roll edges: Smooth (non-textured) to facilitate seaming.
  - 6. Uniform throughout and free from dirt, oil, foreign matter, scratches, cracks, creases, bubbles, tears, holes, pinholes, or other defects which may affect its serviceability.
  - 7. Conform to requirements of Table 31 32 36A - HDPE-Geomembrane Physical Properties. Unless otherwise indicated, required values are minimum average values when tested in weaker principle direction. Test frequency in accordance with GRI GM 13.
  - 8. Seam Strengths: 4 of 5 specimens must meet specified values. Fifth specimen must demonstrate 80 percent of listed value. Seam failure modes shall be Film Tear Bond (FTB).

Table 31 32 36A – HDPE-Geomembrane Physical Properties

Property	Test Method	Requirement
Thickness, minimum average Lowest individual, 8 of 10 readings Lowest individual of 10 readings	ASTM D 5994	76 mils 72 mils 68 mils
Asperity Height <sup>1</sup>	ASTM D 7466	10 mils
Sheet Density	ASTM D 1505 ASTM D 792	0.94 g/cc
Tensile properties <sup>2</sup> : Yield Strength Breaking Strength Yield Elongation Break Elongation	ASTM D 6693	168 lbs/inch 120 lbs/inch 12 percent 100 percent
Tear Resistance	ASTM D 1004	56 lbs
Puncture Resistance	ASTM D 4833	120 lbs
Stress Crack Resistance <sup>3</sup>	ASTM D 5397	300 hours
Carbon Black Content <sup>4</sup>	ASTM D 1603	2.0 to 3.0 percent
Carbon Black Dispersion	ASTM D 5596	Note 5
Oxidative Induction Time (OIT) – Standard OIT	ASTM D 3895	100 minutes
Oven Aging at 85°C High pressure OIT – Percent retained after 90 days	ASTM D 5721 ASTM D 5885	80 percent
UV Resistance <sup>6</sup> High Pressure OIT – (Percent retained after 1600 hours)	ASTM D 7238 ASTM D 5885	50 percent
Roll Dimensions Width Length Area Gross Weight		23 feet 375 feet 8,625 square feet 3,470 lbs (approx.)

Table 31 32 36A – HDPE-Geomembrane Physical Properties

Property	Test Method	Requirement
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## Notes:

1. Of 10 readings; 8 must be  $\geq 7$  mils and lowest individual reading must be  $\geq 5$  mils.
2. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3-inches. Break elongation is calculated using a gauge length of 2.0-inches.
3. The yield stress used to calculate applied load for the SP-NCTL test should be the mean value via MQC testing.
4. Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.
5. Carbon black dispersion for 10 different views. Nine in Categories 1 and 2 with one allowed in Category 3.
6. The condition of the test should be 20-hours UV cycle at 75 degrees C followed by 4-hours condensation at 60 degrees C.
7. UV resistance is based on percent retained value regardless of the original HP-OIT value.

**2.02 HDPE-EMBEDMENT STRIP**

- A. HDPE-embedment strips (rondels) shall be 6-inch wide with anchor-fingers of 1-inch deep for embedment into the concrete structure (GSE PolyLock System or equal).
- B. HDPE-embedment strips shall have a minimum tensile strength of 4,000 lb/in<sup>2</sup>.

**2.03 RUBBER GASKETS**

- A. Rubber gasket shall be type SCE-42 Neoprene/EPT/SBR Closed Cell Medium, 1/4-inch thick by 2-inch wide, with a hardness of 40 to 50 durometer, or solid Butyl Rubber Gasket meeting the same requirements.

**2.04 STAINLESS STEEL CLAMPS**

- A. Stainless steel type 304 clamp, 1/8-inch thick by 1.5-inch wide.

**2.05 FLEXIBLE POLYURETHANE SEALANT**

- A. Flexible polyurethane sealant with a hardness of 40 to 50 durometer, a minimum elongation of 500 percent, and a minimum joint movement of 30 percent (Sikaflex-1a or equal).

**2.06 ACCESORIES**

- A. Other details in accordance with HDPE geomembrane manufacturer's recommendations.

## **2.07 SOURCE QUALITY ASSURANCE**

- A. COR reserves the right to inspect and obtain samples for testing during factory manufacture/fabrication at beginning of production and subsequently.

## **PART 3 EXECUTION**

### **3.01 SUBGRADE PREPARATION**

- A. Prepare surface upon which HDPE geomembrane is to be placed to a firm surface, reasonably even and smooth, and free of abrupt indentations and protruding materials (offsets) greater than 3/4-inch.
- B. Remove any objectionable foreign matter that may puncture HDPE geomembrane.
- C. Obtain COR approval of subgrade before installing HDPE geomembrane.

### **3.02 INSTALLATION**

- A. Install geomembrane in accordance with this Section, as shown on drawings, and in accordance with approved installation plan.
- B. Do not drive equipment on HDPE geomembrane.
- C. Properly protect and maintain any completed geomembrane installations during periods of installation inactivity in accordance with approved installation plan.
- D. Install geomembrane rolls with seams running up and down the slopes. Factory and field seams are not allowed perpendicular to the side slopes unless approved by COR.
- E. Place geomembrane in a slackened condition so it will conform to subgrade contour without being taut when covered with cover material.
- F. Ballast to prevent relocation of compensating slack by wind and to prevent uplift by wind at edges, ends, and other locations as required.
- G. Staking through geomembrane is not allowed.
- H. Overlap adjacent sheets of geomembrane and shingle downstream.
- I. Cover geomembrane as soon as possible after installation.
- J. Damage to geomembrane is sole responsibility of Contractor and shall be repaired immediately using approved repair techniques at Contractor's expense.

- K. Pre-fabricate complete HDPE-embedment strips (rondel) and attach to foundation structure before pouring foundation concrete. Pre-fabricated complete HDPE-embedment strips (rondel) will be composed of welded sections of HDPE-embedment strips, thereby eliminating any gaps between sections after concrete cures, as shown on drawing and in accordance with approved geomembrane installation plan.
- L. Pre-fabricate HDPE pipe-penetration boots with welded seams as required in Section 3.03, in accordance with these specifications, as shown on drawings, with manufacturer's requirements, and in accordance with approved geomembrane installation plan.
- M. Wrinkles:
  - 1. Install geomembrane and cover materials so to minimize geomembrane wrinkles.
  - 2. Cut-out and repair wrinkles or "fishmouths" in geomembrane and seams during coolest part of the day as determined by COR before covering.
  - 3. Install geomembrane and cover materials to achieve intimate contact (pressed-fit) between subgrade, geomembrane and cover material.
  - 4. Work geomembrane wrinkles upslope.
  - 5. Install cover material over geomembrane during coolest part of the day or as approved by COR.

### **3.03 FIELD SEAMS**

- A. Perform continuous field seaming in accordance with manufacturer's instructions, approved geomembrane installation plan and this Section.
- B. Field seams shall form continuous, homogeneous connection between geomembrane panels.
- C. Use dual-track hot wedge welds as primary field seaming method:
  - 1. Use extrusion welds for patches and repairs where dual-track hot wedge welds are not possible.
- D. Install and field seam geomembrane under direct guidance of geomembrane manufacturer's technical representative and in direct presence of installer's geomembrane installation supervisor/field engineer and/or master welder.
- E. Ambient Conditions:
  - 1. Do not perform field seaming when geomembrane is wet or when wind is displacing geomembrane panels.
  - 2. Seam only when air temperature is above 40 degrees F and below 90 degrees F.
- F. Contact surfaces to be field seamed shall be dry and thoroughly cleaned of all dirt, dust, grease, oil, and other foreign materials.

- G. Where seaming of geomembrane panels is required to fabricate the connection between separate portions of geomembrane installation, Contractor shall remove any protective materials used, such as tape, and shall thoroughly clean geomembrane surface(s) to be seamed, using appropriate cleaning agents.
- H. Joining adjacent panels:
1. Overlap geomembrane according to manufacturer's recommendations.
  2. Fusion weld using only approved methods for primary field seaming method.
  3. Finished overlap shall be a minimum of 4-inches, provided, that overlap is sufficient to allow peel tests to be performed on seam.
  4. For cross seam tees associated with fusion welding: panel intersections consisting of three or more panels shall be patched and extrusion welded to a minimum distance of 6-inches on each side of the patch
- I. Patching geomembrane:
1. Finished overlap shall be a minimum of 6-inches, provided, that overlap sufficient to allow peel tests to be performed on seam.
  2. Use only rounded or oval patches.
  3. Cut "fishmouths" or wrinkles along the ridge of the "fishmouth" (wrinkle) to achieve a flat overlap. Seam the cut "fishmouth" or wrinkle and patch any portion where the overlap is insufficient.

### **3.04 ATTACHMENT DETAILS**

- A. Attach geomembrane to HDPE-rondel (embedment strips) with welded seams as required in Section 3.03, in accordance with these specifications, as shown on drawings, with manufacturer's requirements, and in accordance with approved geomembrane installation plan:
1. No voids or spaces shall be left beneath the geomembrane where geomembrane attaches to concrete structures.
- B. Attach geomembrane around existing pipe penetrations with geomembrane boots and using two stainless steel clamps, including a rubber gasket for each clamp, in accordance with drawings and manufacturer's requirements.
- C. Flexible polyurethane sealant shall be placed along the top edge of geomembrane boot and clamp attachment, as shown on drawings.

### **3.05 REPAIRS**

- A. Repair field seams and other damaged area according to manufacturer's recommendations and as approved in geomembrane installation plan.

- B. Repair geomembrane with oval or rounded patch, which overlaps undamaged geomembrane not less than 6-inches.
- C. Test repairs using vacuum method.
- D. Repair and retest unbounded areas detected by air pressure testing and by vacuum testing.

### **3.06 CONTRACTOR QUALITY CONTROL**

#### **A. General:**

- 1. Perform all testing in presence of COR.
- 2. Perform tests at locations and frequencies specified in this section and at other locations and times as determined by COR.

#### **B. Test equipment:**

- 1. Furnish a portable tensiometer with a load readout device.
- 2. Vacuum chamber (box): Apparatus manufactured by American Parts and Service Co., 2201 West Commonwealth Avenue, PO Box 702, Alhambra CA 91802, or equal, having the following essential characteristics:
  - a. Vacuum box assembly consisting of rigid housing, transparent viewing window, and soft neoprene gasket attached to the bottom, port hole or valve assembly, and gauge to indicate chamber vacuum.
  - b. Steel vacuum tank and pump assembly equipped with pressure controller and pipe connections.
  - c. Rubber pressure/vacuum hose with fittings and connections.

#### **C. Test seams:**

- 1. Prepare test seams using excess geomembrane material to verify that field seaming conditions are satisfactory.
- 2. Conduct test seams at the beginning of each seaming shift, at a change of weather conditions, and at least once each 4-hour period during operation for each seaming crew.
- 3. If a test seam fails to meet seam specifications listed in Table 31 32 36A – HDPE-Geomembrane Physical Properties, seaming apparatus and seaming crew shall not be accepted and shall not be used for field seaming until deficiencies are corrected and two consecutive successful test seams have been achieved.
- 4. Test seam shall be at least 3-feet in length with seam centered lengthwise.
- 5. Specimens for testing:
  - 1) 1-inch wide specimens cut from opposite ends of test seam.
  - 2) Not obtained from first or last 6-inches of test seam.

6. Test five specimens in shear and five specimens in peel in accordance with GRI GM 19.

D. Destructive Test for Field Seams:

1. Remove 12-inch by 36-inch samples at locations selected by COR, or when conditions indicate concern for integrity of field seams:
  - a. Standard testing frequency shall be every 500 linear feet of seam length or at a minimum one sample per day. Testing frequency may be increased or decreased at discretion of COR depending on results of Destructive Tests.
  - b. Repair resulting holes in geomembrane with rounded patches and vacuum test.
2. Take 1/3 of Destructive Test sample for Contractor testing. Test 5 shear and 5 peel specimens taken at random from each sample for conformance to values listed in Table 31 32 36A - HDPE-Geomembrane Physical Properties.
3. Overnight mail remaining 2/3 of Destructive Test sample for COR testing and archiving to Bureau of Reclamation, Attn: Code 86-68314, Sixth and Kipling, Building 67, Room 152, Denver CO 80225.

E. Air Pressure Test for dual-track hot wedge welds:

1. Dual-track hot wedge welds shall be non-destructively tested, evaluated and approved in accordance with GRI GM 6.
2. Demonstrate procedure for air pressure testing to COR for approval before testing begins.
3. Test Procedures:
  - a. Pressurize channel between the dual-track hot wedge welds.
  - b. Minimum channel Pressure: 30 psi.
  - c. Minimum Dwell time: 5-minutes.
  - d. Allowable pressure drop: 2 psi.

F. Vacuum testing:

1. Non-destructive test extrusion weld seams by vacuum method in accordance with ASTM D4437.
2. Demonstrate procedure for vacuum seam testing to Government for approval before testing is begun.
3. Test procedures:
  - a. Perform vacuum test with soapy solution.
  - b. Maintain at least 5 psi vacuum for at least 15 seconds, without bubbles appearing from seam.

- c. Overlap 3-inches of seam with vacuum box between tests to ensure that all sections of seam are tested.

G. Recording Results:

1. Record results of test seam and field seam testing and provide daily documentation to COR at end of each shift.
2. Identify field seams, by panel and location where applicable, that initially failed seam testing.
3. Include evidence that field seams or welding equipment were repaired and successfully retested.

H. Do not work above geomembrane layer until:

1. Testing is completed and approved.
2. COR has approved work to begin.

**END OF SECTION**

## SECTION 31 37 00

### RIPRAP

#### PART 1 GENERAL

##### 1.01 MEASUREMENT AND PAYMENT

###### A. Cost:

1. Included in prices offered in the Price Schedules 1 (~~for~~ Pumping Plant No 4) for Tank Drain items requiring riprap as shown on drawings.

##### 1.02 REFERENCE STANDARDS

###### A. American Association of State Highway and Transportation Officials (AASHTO)

- |    |                |   |
|----|----------------|---|
| 1. | AASHTO M288-15 | Geotextile Specification for Highway Applications   |
| 2. | AASHTO T104-99 | Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate   |
| 3. | AASHTO T310-13 | In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)                       |
| 4. | AASHTO T85-14  | Specific Gravity and Absorption of Coarse Aggregate   |
| 5. | AASHTO T99     | Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop |

###### B. ASTM International (ASTM)

- |    |                   |   |
|----|-------------------|---|
| 1. | ASTM C88-05       | Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate   |
| 2. | ASTM C97-02(2008) | Absorption and Bulk Specific Gravity of Dimension Stone   |
| 3. | ASTM C535-16      | Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine                                 |
| 4. | ASTM D698-12e2    | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft <sup>3</sup> (600 <del>KN</del> m/m <sup>3</sup> )) |
| 5. | ASTM D5080-17     | Standard Test Method for Rapid Determination of Percent Compaction  |

### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 35 42 35-1, Certifications:
  - 1. Certified test reports made by an independent testing laboratory indicating that all products meet or exceed requirements.

## PART 2 PRODUCTS

### 2.01 ROCK

- A. Rock from approved sources shall be excavated, selected, and processed to meet specified quality and grading requirements at the time rock is installed.
- B. Consist of hard, dense, durable stone, angular in shape and resistant to weathering to ensure permanence in structure and climate in which it is used.
- C. Rounded stone or boulders shall not be used as riprap material.
- D. Stone shall have a specific gravity of at least 2.5 in accordance with AASHTO T85.
- E. Each piece shall have its greatest dimension not greater than three times its least dimension.
- F. Be rocks or rough quarry stone with:
  - 1. Percent wear of not more than 60 as determined by ASTM C535.
  - 2. Soundness loss of not more than 21 as determined by AASHTO T104.
  - 3. Using a magnesium sulfate solution with a test duration of 5 cycles.
- G. Conform to gradation requirements given in Table ~~34-42-35~~31 37 00A – Riprap Gradation Requirements. Control of gradation will be by visual inspection.

Table ~~35-42-35~~31 37 00A – Riprap Gradation Requirements

Stone Size D50 (In)	Percent Material Smaller Than Typical Stone	Typical Stone Dimensions (In.)	Typical Stone Weight (lbs.)
6	70-100	12	85
	50-70	9	35
	35-50	6	10
	2-10	2	1

- 1. Maximum dimension not greater than 3 times minimum dimension.

## **2.02 GEOTEXTILE**

- A. Provide Class 1 non-woven geotextile (filter fabric) in accordance with AASHTO M288, Table 6 (For *In Situ* Soil which has 15 to 50 percent passing 0.075-mm).

## **PART 3 EXECUTION**

### **3.01 AREAS TO RECEIVE RIPRAP**

- A. Place riprap to outlines and thicknesses as shown on drawings.

### **3.02 PLACING**

- A. Bed riprap on geotextile as shown on drawings.
- B. Rock in riprap need not be hand placed or compacted.
- C. Place rocks so larger rocks are evenly distributed, and small rock fragments fill spaces:
  - 1. Include rock spalls or gravel in an amount to fill voids in riprap, but not in excess of an amount to be determined by OGR.
- D. Dump and smooth by moving rocks into position so material when in place is stable.
- E. Placing riprap on geosynthetics:
  - 1. Drop height, maximum: 1-foot.
  - 2. Before placing riprap, demonstrate placing technique will not damage geotextile or underlying geomembrane:
    - a. If demonstration does not show riprap can be installed without damaging geosynthetic materials, modify riprap placing technique.
    - b. Possible modifications to placing technique include reducing drop height, installing layer of sacrificial geotextile, or installing gravel cushion.
- F. Leave no unreasonably large unfilled spaces within riprap.

**END OF SECTION**

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**SECTION 32 12 22**  
**ASPHALT CONCRETE PAVEMENT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Asphalt Concrete Pavement:
1. Measurement: Weight of material placed, measured at certified scale.
  2. Payment: Ton prices offered in the Price Schedules:
    - a. Includes cost of tack coat.

**1.02 REFERENCE STANDARDS**

- A. New Mexico Standard Specification (NMDOT)
1. NMDOT – 2014 Standard Specification for Highway and Bridge Construction

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 32 12 22-1, Job Mix Formula (JMF):
1. Comply with NMDOT Specification Section 417.2.4 – Job Mix Formula.

**PART 2 PRODUCTS**

**2.01 TACK COAT**

- A. Comply with NMDOT Specification Section 417.2 – Materials.

**2.02 ASPHALT MATERIAL**

- A. Comply with NMDOT Specification Section 416 – Minor Paving.

**PART 3 EXECUTION**

**3.01 CONSTRUCTION REQUIREMENTS**

- A. In accordance with NMDOT Specification Section 417.3 – Construction Requirements.

**3.02 MAINTENANCE**

- A. Maintain paved areas until acceptance of work by Government.

**END OF SECTION**

**SECTION 32 15 10**  
**GRAVEL SURFACING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Gravel Surfacing:

1. Measurement: Volume of in-place compacted material to outlines of area covered and to specified thickness.
2. Payment: Cubic yard prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American Association of State Highway Transportation (AASHTO):

1. AASHTO T 26-08 Test for Quality of Water to Be Used in Concrete

B. ASTM International (ASTM)

2. ASTM D4632-15a Grab Breaking Load and Elongation of Geotextiles
3. ASTM D4751-16 Determining Apparent Opening Size of a Geotextile
4. ASTM D6241-14 Static Puncture Strength of Geotextiles and Geotextile-related Products Using a 50 mm Probe

C. New Mexico State Department of Transportation (NMDOT)

1. NMDOT SS 2014 Standard Specifications for Highway and Bridge Construction 2014 Edition

**1.03 GENERAL**

A. Place gravel surfacing at the following locations:

1. Power Plant No. 4 and Access Road, to the limits shown on drawings.
2. Power Plant No. 7 and Access Road, to the limits shown on drawings.
3. Road Crossings:
  - a. At locations as shown on drawings.
4. Access Road: As shown on drawings.

## **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals
- B. RSN 32 15 10-1, Gravel Certification:
  - 1. Proposed target values for appropriate sieve sizes.
  - 2. Representative 300-lb (150 kg) sample.
- C. RSN 32 15 10-2, Geofabric Installation:
  - 1. Manufacturer's recommendation.
- D. RSN 32 15 10-3, Geofabric Certification:
  - 1. Geofabric meets specified chemical, physical, and manufacturing requirements.

## **PART 2 PRODUCTS**

### **2.01 GRAVEL**

- A. In accordance with NMDOT Standard Specification Section 303 – Base Course:
  - 1. Comply with Table 303.2.1:2 – Type II Base Course Gradation Band of NMDOT SS.

### **2.02 WATER**

- A. In accordance with AASHTO T 26. Do not use residual water, wash water, or recycled water generated by Equipment, mixer trucks, or central mixers.

### **2.03 GEOFABRIC**

- A. 170N non-woven geotextile, manufactured by Mirafi, [www.tencate.com](http://www.tencate.com) or equal with the following essential characteristics:
  - 1. Grab Tensile Strength (ASTM D4632): 180 pounds (lbs).
  - 2. Elongation (ASTM D4632): 50 percent.
  - 3. Puncture Strength (ASTM D6241): 400 lbs.
  - 4. Apparent Opening Size (ASTM D4751): 70 US Sieve size.

## **PART 3 EXECUTION**

### **3.01 ACCESS ROAD PREPARATION AND EXCAVATION**

- A. Clear surface of loose and deleterious material. Ensure top 6-inches of roadbed is free from depressions and soft spots.

- B. Excavate limits of cut section to subgrade elevation for width of roadbed or as prescribed by COR:
  - 1. Excavate in dry conditions.
  - 2. Remove unsuitable or unstable material below finished subgrade.
- C. Finish roadbed to smooth and uniform surface.
- D. Obtain Government approval of subgrade prior to placing gravel surfacing.

### **3.02 PLACING GEOFABRIC**

- A. As directed at locations as shown on drawings.
- B. In accordance with manufacturer's recommendations:
  - 1. Do not tear geofabric during placement and compaction of gravel surfacing.

### **3.03 PLACING AND COMPACTING**

- A. At locations as shown on drawings:
  - 1. Place in layers and compact in accordance with Section 31 23 02 – Compacting Earth Materials.
- B. Route hauling equipment uniformly over full width of surface to minimize rutting or uneven compaction.

### **3.04 DISPOSAL**

- A. Dispose of excess and unsuitable materials in accordance with Section 31 23 39 – Disposal of Excavated Materials.
- B. Grade disposal areas with even and uniform surfaces.

**END OF SECTION**

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**SECTION 32 15 11**  
**AGGREGATE BASE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Aggregate Base:
1. Measurement: Area of subgrade surface required to be covered.
  2. Payment: Ton prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

- A. American Association of State Highway Transportation (AASHTO):
1. AASHTO T 26-08 Test for Quality of Water to Be Used in Concrete
- B. New Mexico State Department of Transportation (NMDOT)
1. NMDOT SS 2014 Standard Specifications for Highway and Bridge Construction 2014 Edition

**PART 2 PRODUCTS**

**2.01 BASE COURSE**

- A. In accordance with Section In accordance with NMDOT Standard Specification Section 303 – Base Course.

**2.02 WATER**

- A. Water:
1. In accordance with AASHTO T 26. Do not use residual water, wash water, or recycled water generated by Equipment, mixer trucks, or central mixers.

**PART 3 EXECUTION**

**3.01 CONSTRUCTION REQUIREMENTS**

- B. In accordance with NMDOT Standard Specification Section 303.3 – Construction Requirements.

### **3.02 MAINTENANCE**

- A. Maintain the aggregate course to the correct line, grade, and cross-section by blading, watering, rolling, or combination thereof until placement of the next course.

**END OF SECTION**

**SECTION 32 17 20**  
**PAINTED TRAFFIC LINES AND MARKINGS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Traffic Lines and Markings:
1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

- A. New Mexico State Department of Transportation (NMDOT)
1. NMDOT SS 2014 Standard Specifications for Highway and Bridge Construction 2014 Edition

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 32 17 20-1, Certification:
1. Manufacturer's certification that paint meets specified requirements.
- C. RSN 32 17 20-2, Instructions:
1. Paint manufacturer's environmental, surface preparation, and application instructions.

**1.04 ENVIRONMENTAL REQUIREMENTS**

- A. Apply when surface and weather conditions are favorable.
- B. Do not apply when air or surface temperature is below 50 degrees F.
- C. Comply with paint manufacturer's environmental restrictions.

**PART 2 PRODUCTS**

**2.01 TRAFFIC PAINT**

- A. In accordance with Section In accordance with NMDOT Standard Specification Section 704 – Traffic Paint.
1. Colors: White and yellow.

**2.02 RECESSED-RETROREFLECTIVE PAVEMENT MARKERS**

- A. Markers: In accordance with NMDOT Standard Specification Section 704.2.6 – Raised Pavement Markers.

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. In accordance with Section In accordance with NMDOT Standard Specification Section 704.3 – Construction Requirements.

**3.02 PROTECTION**

- A. Protect markings from traffic and damage until dry.

**END OF SECTION**

**SECTION 32 31 01**  
**FENCE GROUNDING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Fence Grounding:

1. Payment: Lump sum prices offered in the Price Schedules:
  - a. Includes costs of associated accessories and making connections.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

1. ASTM B228-11a Concentric-Lay-Stranded Copper-Clad Steel Conductors

B. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE 837-2002 Qualifying Permanent Connections Used in Substation Grounding

C. Underwriters Laboratories, Inc. (UL)

1. UL 467-2010 Grounding and Bonding Equipment

**PART 2 PRODUCTS**

**2.01 MATERIALS**

A. General: In accordance with Section 26 05 02 – Basic Electrical Materials and Methods.

B. Ground Cables:

1. Stranded, copper-clad steel in accordance with ASTM B228.
2. Type: 40HS or 40DSA.
3. Bare.
4. Sizes: As indicated on standard drawing 40-D-6376.

C. Cable Fittings, Lugs, and Connectors:

1. Type: As indicated on standard drawing 40-D-6376.
2. Current-carrying Capacity: Equal to associated cable.
3. Copper alloy containing not more than 4 percent zinc.

4. Bolted solderless or compression type connectors: IEEE 837.
5. Ground connectors that will be direct buried or embedded in concrete: Listed for direct burial use in accordance with requirements of UL 467.

D. Ground Rods:

1. Material: Solid, copper-clad steel.
2. Size: 10-foot, with 3/4-inch diameter, nominal.
3. Conform to UL 467.

## 2.02 WELDING PROCESS

A. Molds and Weld Material:

1. Heavy-duty type.
2. Use new material from fresh stock.
3. Weld metal and starting material: No significant quantities of hazardous ingredients.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. This Section applies to facility fence only and only if facility fence is not presently grounded in areas where fence is crossed by or in the right-of-way of new transmission line alignment.

### 3.02 INSTALLATION

- A. General: In accordance with Section 26 05 02 – Basic Electrical Materials and Methods.
- B. As indicated on standard drawing 40-D-6376 except as follows:
1. Grounding cable: Type 40HS, except Type 40DSA may be used for fence fabric weaving.
- C. Ground Rods:
1. Drive vertically full length of rod until top of rod is at required depth below established grade elevation.
  2. Where solid rock is encountered within 3-feet of established grade elevation:
    - a. Drill vertical hole of such depth that top of ground rod will be at required depth.
    - b. Diameter of hole: 1 1/2 times diameter of ground rod.
    - c. Grout rod in hole.

3. Where solid rock is encountered more than 3-feet below established grade elevation:
    - a. Drive rod to refusal at approximately 45 degrees.
    - b. Bend top of rod to lie horizontally at required depth.
  - D. Welding: Install with heavy-duty welding equipment in accordance with manufacturer's instructions:
    1. Use Cadweld, Thermoweld, or equivalent process:
      - a. Personnel shall be properly trained in use and shall be knowledgeable of and follow manufacturer's safety instructions.
    2. COR will witness and test welds.
- 3.03 REPAIR**
- A. Repair metal finishes that have been damaged as a result of grounding connections.

**END OF SECTION**

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**SECTION 32 31 10**  
**CHAIN LINK FENCE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Chain Link Fence:

1. Measurement: Length of chain link fence.
2. Payment: Linear foot prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |                      |   |
|----|----------------------|---|
| 1. | ASTM A121 - 13       | Metallic-Coated Carbon Steel Barbed Wire                                    |
| 2. | ASTM A392 - 11a      | Zinc-Coated Steel Chain-Link Fence Fabric                                   |
| 3. | ASTM A824 - 01(2012) | Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence |
| 4. | ASTM C33/C33M – 16e1 | Concrete Aggregates   |
| 5. | ASTM F567 - 14a      | Installation of Chain-Link Fence  |
| 6. | ASTM F626 - 14       | Fence Fittings  |
| 7. | ASTM F900 - 11       | Industrial and Commercial Swing Gates                                       |

B. Chain Link Fence Manufacturers Institute (CLFMI)

- |    |               |                |
|----|---------------|----------------|
| 1. | CLFMI 2445-10 | Product Manual |
|----|---------------|----------------|

**1.03 SUBMITTALS**

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 32 31 10-1, Certification:

1. Manufacturers' certification that fence materials, fittings, and accessories meet specified requirements.
2. Include manufacturers' names and product designations and specified product standards in the certification.

## **PART 2 PRODUCTS**

### **2.01 CHAIN LINK FABRIC**

- A. Zinc-Coated Steel Fabric: ASTM A392:
  - 1. Size of mesh: 2-inch.
  - 2. Coat before weaving.
  - 3. Diameter of coated wire: 0.148-inch (No. 9-gauge).
  - 4. Coating weight: Class 1.

### **2.02 INTERMEDIATE POSTS**

- A. CLFMI 2445, Type I round pipe.

### **2.03 TERMINAL POSTS, BRACES, AND RAILS**

- A. CLFMI 2445, Type I round pipe.

### **2.04 TENSION WIRE**

- A. Zinc-coated Steel Marcellled Tension Wire: ASTM A824.
  - 1. Coating: Type II, Class 4.

### **2.05 BARBED WIRE**

- A. Steel Barbed Wire: ASTM A121.
  - 1. Coating: Type Z, Class 3.
  - 2. Design Number: 12-2-4-14R.

### **2.06 FITTINGS**

- A. Post and Line Caps, Rail and Brace Ends, Braces, and Bands: ASTM F626, zinc-coated steel or zinc-coated cast iron.
- B. Toprail Sleeves, Tension Bars, and Truss Rods: ASTM F626, zinc-coated steel.
- C. Tie Wires, Clips, and Bands: ASTM F626:
  - 1. Standard round wire ties:
    - a. 9 gage steel.
    - b. Zinc coating, minimum: 1.2 oz/ft<sup>2</sup>.
- D. Barbed wire arms: ASTM F626, Type I.

## **2.07 GATES**

- A. Gates: ASTM F900:
  - 1. Double-swing type.
  - 2. Directions of swing: 180 degrees outward opening.
- B. Frame: CLFMI 2445, Type I round pipe:
  - 1. Corners:
    - a. Welded or heavy fittings.
    - b. Rigid and watertight.
- C. Fabric: Same type used in fence.
- D. Accessories:
  - 1. ASTM F900.
  - 2. Gate hinges, latches, stops, and keepers: Zinc-coated steel or zinc-coated cast iron.

## **2.08 CONCRETE**

- A. Manufacture and delivery: In accordance with Section 03 30 00 – Cast-In-Place Concrete.
- B. Fine and coarse aggregates: ASTM C33:
  - 1. Coarse aggregate size, maximum: 3/4-inch.
- C. Compressive strength at 28-days, minimum: 2,500 lb/in<sup>2</sup>.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Erect chain-link fence and gates at locations shown on drawings.
- B. Install chain link fences of heights shown on drawings.
- C. Install fence and gates as shown on drawings, complete with fabric, posts, braces, rails, fittings, accessories, concrete footings, and other materials required for complete installation of the fence and gates.
- D. Install chain link fence in accordance with ASTM F567 and CLFMI 2445, except as shown on the drawing or specified.

- E. Terminal Posts:
  - 1. Maximum intervals: 500-feet.
  - 2. At vertical and horizontal changes in alignment equal to or greater than 30 degrees.
- F. Undamaged chain link fence fabric removed from existing fence may be used in permanent fence:
  - 1. Reuse of fence posts not allowed.
  - 2. Straighten fabric.
  - 3. Obtain approval of materials to be reused from COR before installation.

### **3.02 GROUND CONNECTIONS**

- A. Provide connections for fence in accordance with Section 26 05 20 – Grounding and Bonding.

### **3.03 REPAIR**

- A. Repair damage to zinc coatings in accordance with Section 09 96 20 – Coatings.

### **3.04 TESTING AND ADJUSTING**

- A. After installation, test and adjust gates for proper operation.

**END OF SECTION**



**PART 2 PRODUCTS****2.01 MATERIALS**

- A. In accordance with NMDOT Section 610.

**PART 3 EXECUTION****3.01 CONSTRUCTION**

- A. Construct in accordance with NMDOT Section 610.
- B. Excavate for cattle guard construction and for suitable drainage of cattle guard.
- C. Construct cattle guard foundations to match roadway cross slope or superelevation specified at cattle guard site.
- D. Handle and erect cattle guards to prevent damage and paint abrasion.

**3.02 REPAIR AND REPLACEMENT**

- A. Repair or replace damaged cattle guards.
- B. Repaint damaged painted surfaces.

**END OF SECTION**

**SECTION 32 91 60**  
**EROSION CONTROL BLANKET**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Erosion Control Blanket:

1. Measurement: Surface area required to be covered, except no allowance will be made for overlaps, repairs, or waste.
2. Payment: Square yard prices offered in the Price Schedules:
  - a. Includes:
    - 1) Erosion Control Blanket Anchors.
    - 2) Coir Wattles.
    - 3) Seeding under Erosion Control Blankets in accordance with Section 32 92 20 – Seeding.

**1.02 REFERENCES**

- A. American Association of State Highway and Transportation Officials (AASHTO))
1. AASHTO T310-13                      Standard Method of Test for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
  2. AASHTO T99-15                      Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
- B. ASTM International (ASTM)
3. ASTM D698-12e2                      Standard Test Methods for Laboratory compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>)

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 32 91 60-1, Manufacturer's Information:
1. Manufacturer's literature listing specified essential characteristics.
  2. Manufacturer's installation instructions.

- C. RSN 32 91 60-2, Installation Plan:
  - 1. Describe sequence of placing blanket.

## **PART 2 PRODUCTS**

### **2.01 SEEDING**

- A. In accordance with Section 32 92 20 – Seeding.

### **2.02 EROSION CONTROL BLANKET**

- A. AEC Premier Coconut erosion control blanket, as manufactured by American Excelsior Company, 850 Avenue H East, Arlington, TX, Telephone: 800-777-7645, or equal, having the following essential characteristics:
  - 1. Machine-assembled mat with 100 percent aspen or coconut excelsior within two layers of netting stitched to form a three-dimensional matrix:
    - a. Netting: Jute or other natural biodegradable fiber.
  - 2. Consistent thickness with aspen or coconut excelsior curled, interlocked, and evenly distributed over entire area of mat.
  - 3. Excelsior color: Sand.
  - 4. Minimum dry unit weight: 8 oz/yd<sup>2</sup>.
  - 5. Thread pattern: 4-inch wide by 4-inch long.
  - 6. Thickness, minimum: 1/2-inch.
- B. Supply blanket in protected, rolled mat form.

### **2.03 EROSION CONTROL BLANKET ANCHORS**

- A. Biodegradable staples, 6-inch minimum length, as recommended by manufacturer.

### **2.04 COIR WATTLES**

- A. BioD-Watl 9, as manufactured by Rolanka International, 155 Andrew Drive, Stockbridge, GA 30281, telephone: 770-506-8211; or equal, having the following characteristics:
  - 1. 100 percent coconut fiber filler material in cylindrical shaped rolls with 2-inch by 2-inch high strength outer netting made of 60-lbs. strength machine spun bristle coir twines.
  - 2. Unit Weight: 1.5 lb/ft.
  - 3. Density: 3.4 lb/cu ft.
  - 4. Diameter: 9-inch.
  - 5. Length: 15- and 20-feet.

## **PART 3 EXECUTION**

### **3.01 EROSION CONTROL BLANKET INSTALLATION**

#### **A. Site Preparation:**

1. Compact bank line excavated for pipe trench backfill beneath erosion control blanket bank protection:
  - a. Compact to 85 percent of maximum density obtained using AASHTO T99 (Standard Proctor) in accordance with AASHTO T310.
  - b. Compact to 85 percent of maximum density obtained using ASTM D698 (Standard Effort).
2. Remove large, sharp objects which include but are not limited to rocks, cut trees, roots, shrubs, glass that may damage erosion control blanket.
3. Grade wash crossing bank slope to the natural topography prior to pipe installation.
4. Seed in accordance with Section 32 92 20 – Seeding just prior to placing erosion control blanket. Seed only under erosion control blanket.

#### **B. Erosion Control Blanket:**

1. Install erosion control blanket on slopes steeper than 2.5:1, at locations shown on drawings or as directed by COR and in accordance with manufacturer's recommended installation procedures and approved installation plan.
2. At overlaps, shingle upstream matting over downstream matting.
3. Secure topsoil erosion control matting in a 6- by 6-inch anchor trench at top and bottom of berms and at upstream and downstream ends of mats.
4. Before backfilling anchor trenches, pin or staple erosion control blanket into anchor trench with no more than 12-inch spacing as recommended by manufacturer.
5. Outside anchor trench, anchor topsoil erosion control matting with 3 to 4 staples per square yard as recommended by manufacturer.

### **3.02 COIR WATTLE INSTALLATION**

#### **A. Anchoring system must be adequate to seat coir wattle securely in contact with adjacent ground:**

1. Place coir wattle at bank toe and at subsequent 12-foot intervals up compacted backfill bank on top of erosion control blanket extending 5-feet beyond disturbed area.
2. Minimum 2-foot overlap between adjoining wattles.
3. A pair of 2-inch by 4-inch wood construction stakes should be placed every 4-feet along coir wattle, one on each side.

4. Piercing coir wattle with stakes should be avoided. Stakes should be driven alongside coir wattle. Coir wattle is secured by tightly sandwiching coir wattle between stakes.
- B. To form a continuous unit, coir wattles must be tied together end-to-end:
1. Use strong synthetic rope to stitch ends together, with knots tied at frequent intervals to ensure reliable connection.

### **3.03 REPAIR**

- A. Repair or replace damaged during installation topsoil erosion control matting at Contractor's expense.

**END OF SECTION**

**SECTION 32 92 20**  
**SEEDING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in square yard prices offered in the Price Schedules for Erosion Control Blanket.

**1.02 DEFINITIONS**

- A. Pure live seed content: Weight of seed times percent purity times percent germination.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 32 92 20-1, Seeding Plan:
1. Equipment.
  2. Name and address of seed suppliers.
- C. RSN 32 92 20-2, Certifications:
1. Origin of seed.
  2. Percent purity and germination.
  3. Prohibited and restricted weed seed content.

**1.04 DELIVERY STORAGE AND HANDLING**

- A. Seed Containers:
1. Sealed.
  2. Labeled:
    - a. Identify seed origin on label.
      - 1) Intrastate shipping: In accordance with New Mexico State Seed Laws and Regulations.
      - 2) Interstate shipping: In accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act.

**1.05 AMBIENT CONDITIONS**

- A. Do not seed when ambient temperature is below 38 degrees F without approval of COR.

- B. Do not seed when ground is snow covered.
- C. Do not seed when wind velocities prevent uniform application of materials or would drift materials.

## **PART 2 PRODUCTS**

### **2.01 SEED**

- A. Weed seeds classified by State Seed Department:
  - 1. Prohibited noxious weeds: None allowed.
  - 2. Restricted noxious weeds: 0.5 percent maximum, by weight.
- B. Seed Mixture:
  - 1. Purity, minimum: 85 percent.
  - 2. Germination, minimum: 85 percent.
    - a. Germination test: Less than 1-year old at time of seeding.
  - 3. Uniform mixture shown in Table 32 92 20A – Seed Mixture.

Table 32 92 20A – Seed Mixture

Common Name	Cultivar	Seeding Rate (Pounds pure live seed per acre)
Wester Wheatgrass	Arriba	3
Streambank Wheatgrass		2
Intermediate Wheatgrass	Oahe	3
Indian Rice Grass	Paloma	2
Blue Grama		2
Sideoats Grama		2
Little Bluestem		2
Rock Mountain Penstemon		1

## **PART 3 EXECUTION**

### **3.01 SEEDBED PREPARATION**

- A. Complete prior to seeding and mulching.
- B. Scarify or harrow and rake topsoil to minimum depth of 3-inches.
- C. Remove stiff clods, lumps, roots, litter, stones, and other foreign material greater than 6-inches in size from surface.

- D. Fill or smooth topsoil surface to remove rills, gullies and depressions.
- E. Protect prepared topsoil surfaces from erosion and washouts. Repair damaged surfaces as required.

### **3.02 SEEDING**

- A. Seed between June 1 and July 31 or October 15 and November 15.

### **3.03 BROADCAST SEEDING**

- A. Broadcast seed only in areas not accessible for drilling.
- B. Mechanical Broadcasting:
  - 1. Equipment:
    - a. Centrifugal type.
    - b. Pull type similar to fertilizer spreader.
  - 2. Designed and regulated to apply seed uniformly at proper rate per acre.
- C. Hand Broadcasting:
  - 1. By hand broadcaster.
  - 2. By hand.
  - 3. Uniformly applied.
- D. Cover seed with soil to depth of 1/4-inch to 1/2-inch immediately after broadcasting:
  - 1. Use hand rake or float.
  - 2. Do not use log chain or similar devices.

**END OF SECTION**

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**SECTION 33 05 23**  
**ROAD CROSSINGS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in applicable prices offered in the Price Schedules for Line Pipe and Gravel Surfacing.
    - a. Includes:
      - 1) Backfill.
      - 2) Compacting of backfill.
      - 3) CLSM.
      - 4) Gravel.
      - 5) Herbicide.

**1.02 REGULATORY REQUIREMENTS**

- A. Conform to Federal, State, Tribal, and local ordinances, rules, and regulations for operations at roadway crossings.
- B. Obtain permits, at Contractor's expense, for work on Federal, Tribal, State and County.
- C. At permitted crossings, Contractor shall provide letter of acceptance from permitter to COR assuring work has been satisfactorily completed.

**PART 2 PRODUCTS**

**2.01 GRAVEL SURFACING**

- A. In accordance with Section 32 15 10 – Gravel Surfacing.

**2.02 CLSM**

- A. In accordance with Section 31 23 70 – Controlled Low Strength Materials (CLSM)

**2.03 GEOFABRIC**

- A. In accordance with Section 32 15 10 – Gravel Surfacing.

**2.04 HERBICIDE**

- A. In accordance with 31 31 30 – Soil-Applied Herbicide.

**2.05 MARKERS**

- A. In accordance with 10 14 26 – Utility Markers.

**PART 3 EXECUTION****3.01 PREPARATION**

- A. Prior to pipeline crossing excavation, slope ground to edge of shoulder as shown on drawings.
- B. Remove and control water in accordance with Section 31 03 33 – Removal of Water from Excavation.

**3.02 PIPELINE CROSSING**

- A. Construct pipeline crossings as shown on drawings:
  - 1. Keep existing roadways open:
    - a. Keep portion of roadway disturbed by crossing as small as practicable.
    - b. Traffic control: See Section 01 55 20 – Traffic Control.
  - 2. Provide detours: See Section 01 55 20 – Traffic Control.

**END OF SECTION**



Table 33 09 13B – Pipe Parameters for Pumping Plant No. 7

Pipe Sizes, Nom. Dia.	16-inch
Pipe Material	Carbon Steel
Flow Range	3500-6500 GPM
Pipe Operating Pressure	260 psi

#### 1.04 SUBMITTALS

- A. Submit the following in accordance with the Section 01 33 00 – Submittals.
- B. RSN 33 09 13-1, Approval Data:
1. Commercial products data for flowmeter systems:
    - a. Sensors with operating cable.
    - b. Microprocessor-based processing unit indicators/transmitters.
    - c. Include manufacturer's name, model number, and specification requirements.
  2. Detailed installation instructions and drawings showing installation details, detail dimensions, and locations of conduit connections. Include manufacturer's instructions for attaching flowmeter to the pipe and cabling to flowmeter display indicator/transmitter.
  3. Schematic and wiring diagrams including those showing connections to external equipment in accordance with Division 26 – Electrical.
- C. RSN 33 09 13-2, Final Data:
1. Service Manuals:
    - a. Bound service manual containing:
      - 1) Installation, maintenance and operating instructions,
      - 2) Identifying parts list,
      - 3) Schematic and wiring diagrams,
      - 4) Recommended parts list.
- D. RSN 33 09 13-3 Test Reports:
1. Simulated test reports.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect all equipment from corrosion, deformation, and other types of damage during delivery, storage and handling.

## **PART 2 PRODUCTS**

### **2.01 FLOWMETER SYSTEMS**

#### **A. Pressure Differential Flowmeter:**

1. V-Cone, model VM, as manufactured by McCrometer, 3255 West Stetson Avenue, Helmet, California, 92545 or having the following salient characteristics:
  - a. 300 psi pressure class.
  - b. Flanges:
    - 1) Class: Match pipe flange.
    - 2) Carbon steel.
  - c.  $\pm 0.5$  Accuracy over specified flow range:
    - 1) 0 upstream diameters.
    - 2) 0 downstream diameters.
  - d. Maximum head loss of 2 psi over full flow range.
  - e. Flow range turndown: 10:1.

#### **B. Remote Indicator/Transmitter (Convertor):**

1. Same manufacturer as flowmeter.
2. Transmitter:
  - a. Provide minimum of one 4 to 20 mA output for flowrate linear to flows.
  - b. RS-485 output: Provide Modbus RTU communication.
  - c. Remote (wall mounted) flowmeter transmitter in NEMA 250, Type 4X enclosure or IP67, with visible display.

#### **C. Provide cable between flowmeter and transmitter of type specified by flowmeter manufacturer that is suitable for pulling through conduit. Determine exact cable length and location of conduit. Cable splicing not allowed.**

#### **D. Provide brackets, supports, and mounting hardware required to install equipment.**

### **2.02 ELECTRICAL EQUIPMENT**

- A. Cable between flowmeter sensor and indicator/transmitter: Type specified by flowmeter manufacturer suitable for pulling through conduit.
- B. Electrical conduit between sensor and indicator/transmitter to be provided in accordance with Division 26 – Electrical.
- C. Electrical service for device operation: 115-volts, single phase, 60 hertz.

## 2.03 FINISHES

- A. Coat in accordance with Section 09 96 20 – Coatings.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Pumping Plant No. 4:

1. Install new flow measuring devices in accordance with these specifications, the manufacturer's recommendations, and as shown on layout drawing 1695-D-60391:
  - a. Install flowmeters:
    - 1) 153-FIT-001
    - 2) 153-FIT-002
    - 3) 153-FIT-003
    - 4) 153-FIT-004
    - 5) Indicator/Transmitter Location:
      - a) Mount transmitters grouped in enclosures as is shown in supplied conduit plan drawings. Enclosure shall meet requirements for boxes in Section 26 05 33 – Raceway and Boxes.
      - b) Transmitter display shall be visible from outside the enclosure.

- B. Pumping Plant No. 7:

1. Install new flow measuring devices in accordance with these specifications, manufacturer's recommendations, and as shown on layout drawing 1695-D-60389:
  - a. Install flowmeters:
    - 1) 163-FIT-001
    - 2) 163-FIT-002
    - 3) 163-FIT-003
    - 4) 163-FIT-004
    - 5) Indicator/Transmitter Location:
      - a) Mount transmitters grouped in enclosures as is shown in supplied conduit plan drawings. Enclosure shall meet the requirements for boxes in Section 26 05 33 – Raceway and Boxes.
      - b) Transmitter display shall be visible from outside the enclosure.

- C. Mount remote flowmeter indicators/transmitters in respective electrical panel as shown on drawing 1695-D-60554.
- D. Signal cable from each transducer/sensor to run in new conduit as follows:
  - 1. Provide rigid and flexible conduit as required.
- E. Furnish bolts, brackets, supports, and mounting hardware required to install equipment.
- F. Make connections between flowmeter indicators/transmitters and flowmeter sensors:
  - 1. Cable splicing not allowed.
  - 2. Cable to run in grounded conduit (flexible and rigid) between flowmeter sensors and respective indicator/transmitter.
- G. Make connections between flowmeter indicator/transmitter and incoming power.
- H. Electrical:
  - 1. Install in accordance with Division 26 – Electrical.
  - 2. Install electrical wiring, shielded telemetry cable, conduit, power supplies, electrical boxes, terminal blocks, and necessary accessories required to complete installation.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. General:
  - 1. Perform tests after installing flowmeter systems.
  - 2. Tests shall be witnessed by COR. Notify COR at least 5-days in advance of when tests are to be performed.
  - 3. Furnish testing equipment and additional hardware necessary for complete testing.
- B. Simulated Tests: Demonstrate equipment operates in accordance with this Section, including:
  - 1. Apply simulated flow signal inputs. Simulated signals to cover minimum and maximum flows over the velocity range listed in Tables 33 09 13A – Pipe Parameters for Pumping Plant No. 4 and 33 09 13B – Pipe Parameters for Pumping Plant No. 7.
  - 2. Check displays for correct readouts, and check each I/O (input/output) point for correct I/O signal.
  - 3. Test each output connection for correct output conformance.
  - 4. Verify all instrumentation and indication devices function properly. Test all functions of flowmeter transmitter for correct operation.
- C. Make corrections and adjustments to provide complete installation satisfactory to COR.

**END OF SECTION**

**SECTION 33 09 15**  
**FLOOD DETECTION AND ALARM SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Flood Detection and Alarm System:
1. Payment: Lump sum prices offered in the Price Schedule 1 (Pumping Plant No. 4).

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 33 09 15-1, Approval Data:
1. Manufacturer's literature, specifications, and engineering data including dimensions, size and materials of the following:
    - a. Flood detection system equipment. Include electrical schematics, wiring diagrams, and proposed mounting options.
- C. RSN 33 09 15-2, Final Drawings and Data:
1. Data previously approved under RSN 33 09 15-1.
  2. Installation, Operational and Maintenance Manual.

**1.03 QUALIFICATIONS**

- A. Manufacturer's Qualifications:
1. 5-years of experience producing substantially similar equipment. Show 5 satisfactory installations for at least 5-years.

**PART 2 PRODUCTS**

**2.01 POWER SUPPLY**

- A. Model PS-4 Water Alert Power Supply Model, manufactured by Dorlen Products Incorporated, 6615 West Layton Avenue, Milwaukee, WI 53220, Phone: 414-282-4840; or equal, having the following essential characteristics:
1. Compatible with provided sensing probes.
  2. 120 VAC.
  3. Internal and rechargeable battery back-up system.

4. Short circuit and thermal overload protection.
5. UL listed input transformer.

## **2.02 FLOOD DETECTOR SENSORS**

- A. Model VR-4 Water Alert Detectors with Model VR-KIT Conduit Kit manufactured by Dorlen Products Incorporated, 6615 West Layton Avenue, Milwaukee, WI 53220, Phone: 414-282-4840; or equal, having the following essential characteristics:
1. Commercial grade.
  2. One (1) stainless steel sensing probe.
  3. Activated by conductive fluid bridging the sensors.
  4. Stainless steel mounting hardware.
  5. Protect electronic circuitry from environmental conditions and temporary immersion in water by heavy-duty powder-coated housing.
  6. Double Pole Double Throw (DPDT) relay contact outputs rated at 1-amp, 28-VDC maximum for tie-in to alarm panels.
  7. Powered by provided power supply.
  8. Water-tight conduit fittings.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Electrical wiring, metal conduit, junction boxes, power supplies, electrical boxes and accessories to install system in accordance with Division 26 – Electrical.
- B. Install sensor probe and power supply in accordance with manufacturer's instructions and as approved by COR:
1. Locate power supply and probe in south-west corner of utility vault.
  2. Mount power supply no less than 36-inches above finished floor elevation with stainless steel hardware.
  3. Install probe 3-inches above finished floor elevation. Coordinate installation location of sensor with COR.
- C. Route output signal wire through conduit to SCADA system as shown on drawings.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Test flood detection and alarm system to verify successful installation and operational conditions in accordance with manufacturer's recommendations.

- B. Notify COR in writing at least 7 working days prior to testing. Include:
  - 1. Proposed testing date and time.
  - 2. Period of time required to complete testing.
- C. Tests may be witnessed by Government.

**END OF SECTION**

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**SECTION 33 11 10**  
**PIPELINE GENERAL REQUIREMENTS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Line Pipe for the following, Reach 7, Sheep Spring Turnout, Pumping Plant 4 Drain, and Temporary 6-inch Construction Waterline:
1. Measurement: Horizontally along pipe centerline, without allowance for slope, between ends of pipe in place. Continuous through fittings, outlets, wash crossings, casing pipes, end collars, thrust restraints, and road crossings with no allowance for lap at joints:
    - a. Measurement for pipe from pipe outlets will begin at downstream face of valve or flange.
  2. Payment: Linear foot prices offered in applicable Price Schedule 1 (Pumping Plant 4):
    - a. Includes cost of the following:
      - 1) Pipe trench excavation in accordance with Section 31 23 22 – Pipe Trench Earthwork.
      - 2) Furnishing and placing materials, including but not limited to the following:
        - a) Fittings, bedding, embedment, utility markers, concrete, reinforcing steel, blocking and collars, not included elsewhere.
        - b) Asphalt concrete pavement.
        - c) Laying pipe.
    - b. Linear foot price shall be an average price of pipe pressure class shown on drawings.
- B. Filling and Testing Pipe:
1. Cost: Include in prices offered in applicable Price Schedule for Line pipe.
    - a. Includes: One pipe volume of water used for filling and testing or as approved by OGR.
    - b. Additional water required for flushing and testing is at Contractor's expense.

## 1.02 DEFINITIONS

Material	Piping Types		
	Location	Specification	Drawings
PVC or Steel	Line Pipe, outside of pumping plant yard	As per material type.	1695-D-60704, 1695-D-60715, 1695-D-60732, 1695-D-60767, 1695-D-60768
Steel only	Assembly Piping, Vaults and Yard piping	33 21 95 – Steel Manifold Piping	1695-D-60722

### A. Line Pipe:

1. Pipe sizes and classes: Line Pipe is designated on plan and profile drawings by an alphanumeric symbol:
  - a. Symbol identifies pipe diameter, cover class and hydraulic transient head as follows:
    - 1) First number in symbol indicates nominal diameter in inches.
    - 2) Alphabetic character represents cover class of pipe where; B < 10 feet, C < 15 feet, and D < 20 feet:
      - a) K Class pipe: Metallic pipe with a special design at locations shown on the drawings:
        - i. Joints shall be butt welded if steel pipe is used.
        - ii. Joints shall be restrained if ductile iron is used.
    - 3) Second number in symbol is maximum hydraulic transient head measured to centerline of pipe.
    - 4) A symbol of 42C600 means pipe is 42-inches in diameter with a cover between 10- and 15-feet and a hydraulic transient head of 600-feet at centerline of pipe.
2. Unless specific reference is made to outside or inside diameter of pipe, pipe diameters shown on drawings and used in this section are nominal pipe diameters.

### B. Metal Piping for Line Pipe Installations:

1. In accordance with Section 33 21 95 – Steel Manifold Piping.
2. Piping in vaults, turnouts, or piping for appurtenances such as blowoffs, bypasses, air valves or manholes including air vent piping in manholes.
3. Includes, buried manholes, outlets and associated flanges from the line pipe to which metal piping for line pipe is attached.

### 1.03 REFERENCE STANDARDS

- A. ASTM International (ASTM)
1. ASTM C150/C150M-17 Portland Cement
  2. ASTM F2164-13 Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems using Hydrostatic Pressure.
- B. American Water Works Association (AWWA)
1. AWWA C205-12 Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 In. (100mm) and Larger - Shop Applied
  2. AWWA C600-10 Installation of Ductile Iron Water Mains and Their Appurtenances
  3. AWWA C604-11 Installation of Steel Water Pipe 4 In. (100mm) and Larger
  4. AWWA C605-13 Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
- C. International Organization for Standardization (ISO)
1. ISO 9001-15 Quality Management
- D. National Sanitation Foundation (NSF)
1. NSF Standard 61-16 Drinking Water System Components - Health Effects

### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittals:
- B. RSN 33 11 10-1, Qualifications:
1. Certification of line pipe layers (Foreman).
  2. Certification of line pipe and fitting manufacturers.
  3. Certification of NSF 61 compliance of line pipe materials.
- C. RSN 33 11 10-2, Pipelaying Diagrams:
1. RSN 33 11 10-2, (Reach 7).
    - a. Submit after utility crossing investigation and wash crossing field information has been submitted and approved for that section:

- b. For each type of pipe furnished.
- c. Show position and marking of pipe sections.
- d. Include centerline and invert stationing and elevations at horizontal and vertical changes in alignment, and subgrade elevation for each pipe segment and fitting.
- e. Include pipe thickness, Dimension Ratio (DR) or pressure class of pipe segment or fitting.
- f. For alignment changes not using a miter bend (pulling joints) provide station at point of curvature and point of tangent, and deflection angle at each pulled joint.
- g. Include Shop Drawings for applicable pipe type.

D. RSN 33 11 10-3, Filling and Testing Plan:

- 1. Proposed rate, time, and procedure for:
  - a. Cleaning.
  - b. Filling.
  - c. Field and pressure testing.
  - d. Draining pipeline.
- 2. Method for disposing of water drained from pipeline to enable repair of leaks.

E. RSN 33 11 10-4, Flotation Prevention Plan:

- 1. Show location and describe method of preventing pipe from floating.
- 2. Provide supporting calculations.

F. RSN 33 11 10-5, Pipe Deflection Measurements.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Ship pipe after receiving OGR approval as per Section 2.03 – Source Quality Assurance.
- B. Prevent damage to pipe and fittings during loading, transporting, unloading, storing, and laying.
- C. Transport metallic pipe and fittings on padded bolsters curved to fit outside of pipes. Use heavy padding under ties.
- D. Tightly close open ends of shop-applied, cement-mortar-lined pipe with plastic wrap for protection of cement-mortar lining during shipment:
  - 1. Plastic Wrap:
    - a. At least 2 thicknesses of 6-mil sheet polyethylene plastic.
    - b. Remain on pipe until installation.

- E. Support and store pipe above ground surface. Do not allow bells and spigots to contact each other or the ground.
- F. Government will inspect pipe once it is delivered.
- G. Replace or repair, as approved by OGR, any pipe that is damaged during shipment, storage, or installation at Contractor's expense. Include linings and coatings.

## **1.06 QUALIFICATIONS**

- A. Pipe manufacturers shall be certified in accordance with ISO:9001 or similar nationally certified program approved by OGR.
- B. Line pipe and specials manufacturers:
  - 1. 10-years successful experience producing products as specified.
  - 2. Provide references for at least 3 completed projects with similar pipe diameters and pressures.
- C. Pipe Layers: Skilled and experienced in laying pipe with joints as needed for each material type of pipe used. Minimum 2-years installing pipe with similar pipe diameters, pipe material, and pressures:
  - 1. In the absence of specific pipe material experience, substitution of onsite pipe manufacturer training and quality control is allowed:
    - a. Provide manufacturer's representative certified in pipeline installation, including all applicable joints, for training pipe layers and pipe foreman prior to installation.
    - b. In lieu of specific pipe material installation experience, pipe layers and pipe foreman shall still have experience with installing similar pipe diameters and pressures.
- D. Qualify welding procedures and welders in accordance with code under which welding is specified.

## **PART 2 PRODUCTS**

### **2.01 PIPE OPTIONS**

- A. In accordance with the following Sections:
  - 1. 33 11 12 – Steel Line Pipe
  - 2. 33 11 17 – PVC Pressure Pipe
- B. Locations:
  - 1. Sheep Spring Turnout pipe material and types listed in 2.01 – Pipe Options.
    - a. 6-inch nominal diameter, Line Pipe.

2. Reach 7; pipe material and types listed in 2.01 – Pipe Options:
    - a. PVC not allowed.
    - b. 42-inch nominal diameter, Line Pipe.
  3. Pumping Plant 4 Drain, pipe material and types listed in 2.01 – Pipe Options:
    - a. 36-inch nominal diameter, Line Pipe.
  4. Temporary 6-inch Construction Waterline, pipe material and types listed in 2.01 – Pipe Options:
    - a. 6-inch nominal diameter, Line Pipe.
- C. Materials and chemicals that may come into contact with drinking water shall be certified by NSF 61.
- D. Rubber Gaskets:
1. Manufactured and tested in accordance with applicable AWWA standard for pipe type.
  2. Petroleum-Resistant Gaskets: Use in pipe joints in accordance with Section 33 11 50 – Pipe Crossings at Existing Utility Pipelines.
  3. Lubricant: Approved for potable water use.

## **2.02 FITTINGS**

- A. Fittings should resist same loading conditions as adjacent pipe.
- B. Refer to applicable line pipe section for allowed fittings.

## **2.03 SOURCE QUALITY ASSURANCE**

- A. Approval for Shipment:
  1. Pipe and fitting approval will be determined by inspection, during and after manufacture.
  2. Notify Technical Service Center, Attn: 86-68140, and COR at least 14-days before manufacturing pipe and fittings and 3-days before shipping pipe and fittings.
  3. Government will inspect pipe units and fittings and will approve for shipment those which have been manufactured and tested in accordance with these specifications, unless Contractor is notified in writing.
  4. Further inspection of pipe units and fittings will be in accordance with clause at FAR 52.246-12 Inspection of Construction.

## 2.04 PIPE ACCESSORIES

- A. Air Valve and Manhole Assemblies: In accordance with Section 33 22 14 – Valves and Equipment.
- B. Manholes:
  - 1. Cement-mortar lining: AWWA C205, in accordance with shop applied mortar for lining of specials, except:
    - a. Reinforcement required for pipe larger than 24-inch diameter.
    - b. Cement: ASTM C150, Type V.
  - 2. Required at locations shown on drawing 1695-D-60704.
- C. Warning Tape:
  - 1. Polyethylene tape.
  - 2. Thickness: 4 mils.
  - 3. Magnetically detectable.
  - 4. Width, minimum: 6-inches.
  - 5. Color: Blue with silver lettering.
  - 6. Legend repeated at least every 3-feet: “CAUTION: WATERLINE BURIED BELOW - FOR MORE INFORMATION CONTACT THE NAVAJO TRIBAL UTILITY AUTHORITY”.
- D. Tracer Wire for Non-Metallic Pipe:
  - 1. Type: High strength copper clad steel.
  - 2. Size: 10 AWG, minimum.
  - 3. Insulation:
    - a. High density, high molecular weight, polyethylene (HDPE).
    - b. Jacket Color: Blue.
    - c. Rated for direct burial.
- E. Tracer Wire Terminal Post:
  - 1. Designed and manufactured for specific application.
  - 2. Temperature and ultraviolet light stable.
  - 3. Color: Blue.
  - 4. Terminals: Two, minimum, per post.
  - 5. Provide terminal jumpers to interconnect lengths of trace wire as needed.
  - 6. Space as recommended by manufacturer.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Perform cleaning, filling, and testing after backfill has been placed to finished grade or as approved by OGR.
- B. In accordance with 01 71 20 – Surveying.
- C. Protect pipe from contamination, damage, and elements during storage on-site by covering with tarp as directed by OGR.
- D. Install pipe based on these specifications or pipe manufacturer's recommendation, whichever is more stringent.

### **3.02 INSTALLATION**

- A. Install pipe in accordance with appropriate Section for pipe option installed.
- B. Keep openings to installed pipe closed with watertight inflatable plugs during work stoppage, including end of work day, breaks, and work delays.
- C. If pipe is flooded during construction, clear floodwater by draining and flushing with water, or other approved method, until pipe is clean.
- D. Lubricant:
  - 1. Keep clean.
  - 2. Apply with dedicated, clean applicator brushes.
  - 3. Apply lubricant as specified by pipe manufacturer:
    - a. Use only lubricant supplied by pipe manufacturer.
- E. Coat buried manholes with cement mortar as shown on drawings.
- F. Install tracer wire for non-metallic pipe.
- G. Install warning tape over center of pipe at least 18-inches below ground and at least 18-inches above pipe.

### **3.03 LAYING PIPE**

- A. Excavate pipe trench in accordance with Section 31 23 22 – Pipe Trench Earthwork.
  - 1. Grade pipe trenches to provide uniform slope along bottom of pipe.
  - 2. At joints involving bells or collars, provide holes at joint of ample size to prevent bells or collars from coming in contact with subgrade and to allow for bedding placement.
- B. Keep pipe trenches free of water during pipelaying operations.

- C. Lower pipe into trench and place pipe in position such that no soil gets inside pipe and pipe is not damaged.
- D. Install pipe to line and grade as shown on drawings and approved lay diagrams.
- E. On grades exceeding 10 percent, lay pipe uphill.
- F. When pipelaying is not in progress, keep ends of pipelines closed with watertight inflatable plugs.
- G. Joining Pipe:
  - 1. Assemble push-on or mechanical joints in accordance with applicable AWWA standard for pipe type and manufacturer's recommendations.
  - 2. If adjustment of the position of length of pipe is required after installation, remove and relay length of pipe as new pipe.
  - 3. Maintain pipe firmly in final position.
  - 4. Placing Elastomeric Gasket:
    - a. Clean gasket, bell, especially the groove, and spigot with rag, brush, or paper towel to remove any dirt or foreign material.
    - b. Use only gaskets which are designed for and supplied with pipe.
    - c. Lubricate pipe as recommended by manufacturer.
    - d. Spigot Groove Method:
      - 1) Follow manufacturer's recommended practices for gasket installation.
      - 2) After placing elastomeric gasket in spigot groove, equalize elastomeric gasket cross section by inserting tool such as a large screwdriver under elastomeric gasket and moving it around periphery of pipe spigot.
    - e. Coupling Groove Method: Follow manufacturer's recommended practices for gasket installation. Typically, factory installed.
  - 5. Fit pipe unit's together, spigot to bell or coupling, and draw joints together so that bells or couplings and spigots are fully engaged with uniform contact to gasket.
  - 6. Do not swing or "stab" joint and do not suspend pipe and swing into bell or coupling.
  - 7. Fit pipe units together in a manner to avoid twisting or otherwise displacing or damaging elastomeric gasket.
  - 8. After joining pipe units, insert feeler gauge between pipe bell and pipe spigot, move it around periphery of pipe to determine that position of elastomeric gasket is correct and there are no fish-mouth problems. If adjustment of position of a length of pipe is required after installation, remove and relay length of pipe as new pipe.

- H. Changes in Alignment and Grade:
1. Make changes in alignment and grade with miter bends as shown on drawings.
  2. Make other minor changes in alignment and grade by providing small deflections between adjacent pipe. Do not exceed manufacturer's deflection tolerances.
  3. Provide restrained joint lengths upstream and downstream of bends or thrust blocks as shown on drawings. Ductile iron fittings with restrained joint lengths as limited by drawings may be used if Contractor submits revised plan and profile drawings for approval.
  4. Do not encase rubber gasket joints in concrete.
  5. Refer to individual pipe Sections for additional requirements. If requirements conflict, use most stringent requirement.
- I. Schedule work so that at no time pipe remains in trench more than 7-days before backfill is placed to original ground surface or to other specified backfill limits shown on drawings.
- J. Joints under Wash Crossing banks and waterway shall be restrained for length shown on drawings. Joints shall have hoop stress and longitudinal stress capacity equal to or greater than adjacent pipe.

### **3.04 THRUST RESTRAINT**

- A. Restrained joint couplings as shown on drawings.
- B. Plan, profile and restraint system shown on drawings require modification if alternate methods are used.
- C. Alternate methods of restraint may not be used unless submitted and approved by COR.

### **3.05 TRACER WIRE**

- A. Install continuous length of tracer wire for full length of each run of non-metallic pipe,
- B. Attach wire to top of pipe using suitable methods to ensure tracer wire will not be displaced during construction operations.
- C. Locate tracer wire terminal posts at suitable locations to provide testing and/or jumper points for entire length of non-metallic pipe.
- D. Verify tracer wire continuity prior to performing backfill operations.

### **3.06 BACKFILL**

- A. Backfill pipe in accordance with Section 31 23 22 – Pipe Trench Earthwork:
  - 1. Place backfill about pipe carefully to avoid lateral displacement of pipe and damage to joints.
  - 2. In certain pipeline reaches, where determined necessary by OGR to prevent possibility of flotation, do not lay more than 300-linear feet of pipe ahead of backfilling operations.
  - 3. If pipelaying operations are interrupted for more than 24-hours, cover pipe laid in trench with backfill.

### **3.07 PIPE DIAMETER DEFLECTION**

- A. For pipe greater than 24-inches:
  - 1. Measure short term deflection of internal diameter:
    - a. Within 2-weeks after completion of backfill.
    - b. When interior bracing required, remove before making measurements.
  - 2. Measurement Frequency:
    - a. One pipe unit out of 3 for first 30 units laid. 1 pipe unit out of 10 thereafter.
    - b. In deep burial or problem areas, frequency of measurements may be increased at discretion of OGR.
  - 3. Measurements:
    - a. Measure vertical and horizontal diameter at approximate midpoint of pipe unit.
    - b. Record pipe deflections and station where measurements were taken.
    - c. Mark inside of pipe so that future comparisons can be made.
- B. Deflection limitations apply per individual pipe sections.
- C. Take corrective action if required limits are not meet, including removing and replacing pipe that exceeds allowable deflection tolerance.

### **3.08 FIELD EXAMINATION**

- A. Pipe Flushing.
  - 1. Flush foreign material from pipeline prior to testing.
  - 2. Flush using a minimum velocity of 3-feet per second toward low points in reach.
  - 3. Flush maximum 3 pipe volumes until water is clean or approved by OGR.

4. Dispose of flush water in accordance with permits in Section 01 57 30 – Water Pollution Control.
5. Operate valves several times during flushing period.

### **3.09 FILLING AND DRAINING PIPELINE**

- A. Notify OGR 4-days before filling and testing.
- B. Water for filling and testing pipeline in accordance with Section 01 51 00 – Temporary Utilities.
- C. Pipeline fill rate, maximum: 2 cubic feet per second.
- D. Maintain pipeline completely filled for at least 72-hours before testing.
- E. Dispose of testing water by approved method as directed by OGR.

### **3.10 CONTRACTOR FIELD QUALITY TESTING**

- A. Leak testing pipeline:
  1. Notify OGR at least 7-days before applying pressure to pipeline.
  2. Do not start leak testing when snow or standing water is on the ground. Suspend testing as directed by OGR if precipitation accumulates on the ground.
  3. Furnish pumps, power, pressure gages, and air valves at each end of pipeline and calibrated flow meters for testing.
  4. Comply with applicable test standard except as noted below:
    - a. AWWA C605 for PVC.
    - b. AWWA C604 for Steel.
  5. Test pipeline with hydrostatic pressure equal to elevations listed for each Reach:
    - a. Reach 7; Elevation 5889 feet.
    - b. Sheep Spring Turnout; Elevation 6245 feet.
    - c. Temporary 6-inch waterline, Elevation 5889 downstream of PRV
    - d. Pumping Plant 4 Drain, pressure test not required.
    - e. Test Segment: Each pipe segment between start and end.
  6. Prior to starting test, maintain pressure in pipe for 24-hours.
  7. Test for 96-hours or as approved by OGR.
  8. Measure volume of water required to maintain pressure during test:
    - a. Acceptance criteria:
      - 1) Measured leakage shall not be greater than test allowance prescribed by the following test method:
        - a) AWWA C604 for Steel Pipe.
        - b) AWWA C605 for PVC.

- b. If criteria are not met, repair or replace pipe or fitting and repeat test until acceptance criteria is achieved.
  9. Drain pipe using both gravity flow and sump pump at blowoffs or as approved by OGR.
  10. Seal openings to pipe as approved by OGR.
- B. Locate tracer system testing:
1. Perform test of tracer wire system using applicable equipment along entire length of pipe to ensure proper performance.
  2. Repair any identified breaks or separations and retest applicable section of system.

**END OF SECTION**

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**SECTION 33 11 12**  
**STEEL LINE PIPE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. In accordance with Section 33 11 10 – Pipeline General Requirements.

**1.02 PROJECT CONDITIONS**

- A. Does not include pipe specified in Section 33 21 95 – Steel Manifold Piping.

**1.03 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |                        |  |
|----|------------------------|--|
| 1. | ASTM A139/A139M-16     | Electric-Fusion (Arc) - Welded Steel Pipe (NPS 4 and Over)   |
| 2. | ASTM A283/A283M-18     | Low and Intermediate Tensile Strength Carbon Steel Plates  |
| 3. | ASTM A1011/A1011M-15   | Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Allow and High-Strength Low-Allow with Improved Formability  |
| 4. | ASTM A1018/A1018M-16a5 | Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability |
| 5. | ASTM E165/E165M-12     | Liquid Penetrant Examination for General Industry  |
| 6. | ASTM E709/E709M-15     | Standard Guide for Magnetic Particle Testing   |

B. American Welding Society, Inc. (AWS)

- |    |                   |                                 |
|----|-------------------|---------------------------------|
| 1. | AWS D1.1/D1.1M-15 | Structural Welding Code – Steel |
|----|-------------------|---------------------------------|

C. American Water Works Association (AWWA)

- |    |              |  |
|----|--------------|--|
| 1. | AWWA C200-12 | Steel Water Pipe - 6 Inch (150mm) and Larger |
|----|--------------|--|

- |    |              |   |
|----|--------------|---|
| 2. | AWWA C205-12 | Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch (100mm) and Larger - Shop Applied |
| 3. | AWWA C206-17 | Field Welding of Steel Water Pipe   |
| 4. | AWWA C208-12 | Dimensions for Fabricated Steel Water Pipe Fittings   |
| 5. | AWWA C227-11 | Bolted, Split-Sleeve Restrained and Non-restrained Couplings for Plain-End Pipe                             |
| 6. | AWWA C604-11 | Installation of Buried Steel Water Pipe 4 Inch (100 mm) and Larger  |
| 7. | AWWA M11-04  | Steel Pipe: A Guide for Design and Installation, Fourth Edition   |

#### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 33 11 12-1, Shop Drawings:
1. Show pipe and fitting fabrication details.
  2. Show exact dimensions of joints and proposed joint restraint.
  3. Show exact dimensions of welding lead holes and repair method.
  4. Show details of factory epoxy lining of joint cement mortar hold back area if alternate epoxy joint recess lining is proposed.
  5. See RSN 33 11 10-2 for further details.
- C. RSN 33 11 12-2, Ventilation Plan:
1. Method for ventilating inside of pipe when placing mortar lining for joints.

#### **1.05 GENERAL**

- A. In accordance with applicable portions of Section 33 11 10 – Pipeline General Requirements.

### **PART 2 PRODUCTS**

#### **2.01 STEEL LINE PIPE**

- A. Pipe:
1. Electric fusion (arc) welded helical-seam steel pipe: ASTM A139, Grade C, D, or E.
  2. Fabricated in accordance with AWWA C200:

- a. Except:
  - 1) Steel plate: ASTM A283, Grade C or D.
  - 2) Steel Sheet or coil: ASTM A1011, designation SS, Grade 40, 45, or 50; or ASTM A1018, designation SS, Grade 40 or designation HSLAS-F, Grade 50.
- B. Inside diameter measured to inside of lining shall not be less than nominal diameter shown on drawings.
- C. Minimum Steel Wall Thickness:
  - 1. Greater thickness from the following requirements:
    - a. Steel Wall Thickness for Handling:
      - 1) Equal to inside diameter (inches) of pipe steel shell divided by 240 for mortar lined and flexible coated steel pipe.
    - b. Steel Wall Thickness for Internal Pressure:
      - 1) Hoop stress of pipe shell. Not to exceed:
        - a) 50 percent yield strength as defined by steel grade of steel using the Barlow formula. With pressure defined by Hydraulic Grade Line as shown on pipeline plan and profile drawings.
        - b) 75 percent yield strength as defined by grade of steel using the Barlow formula. With pressure defined by pipe head class as shown on pipeline plan and profile drawings.
      - 2) Barlow formula as defined by AWWA M11 Equation 4-1.
    - c. Steel Wall Thickness for Steep Pipe (“K”): Minimum 0.25-inches or greater as required for Internal Pressure.
- D. Steel shall be fully killed and conform to fine grain practice.
- E. Rubber gaskets: In accordance with AWWA C200.

## **2.02 FITTINGS**

- A. Steel: ASTM A283, Grade C or D or ASTM A1011, designation SS, Grade 40, 45, or 50; or ASTM A1018, designation SS, Grade 40 or designation HSLAS-F, Grade 50.
- B. Minimum steel wall thickness and fitting dimensions: In accordance with AWWA C200, AWWA C208 and AWWA M-11.
- C. Welding:
  - 1. AWS D1.1.

- D. Lifting eyes and other handling devices: Made part of fitting before lining and coating are applied.
- E. Bolts and Nuts: ASME B18.2.1 and FS FF-N-836.
- F. Coating and lining in accordance with Section 09 96 20 – Coatings.
- G. Cement-Mortar Lining for Specials and Bends Larger than 24-inches:
  - 1. In accordance with AWWA C205.
  - 2. Apply lining with a resultant surface finish, including joints, equal to finish of adjacent pipe.
- H. Joints between fittings and ductile iron pipe:
  - 1. Rubber gasket joints.
  - 2. Joint dimensions and tolerances: Same as pipe manufacturer's joint design.
- I. Miter Bends: Fabricate steel bends in accordance with AWWA C208, AWWA M-11 and as shown on drawings.
- J. Pipe Couplings:
  - 1. Coupling types as shown on drawings.
  - 2. Suitable for line pipe materials used.
  - 3. Suitable for cold water pressures of pipe head classes on drawings.
  - 4. Refer to Section 33 21 95 – Metal Piping for Line Pipe Installations for coupling requirements.
- K. Closure Section Joints
  - 1. Restraint requirements shown on drawings.
  - 2. Field welded butt strap joints.
  - 3. Bolted, Split-Sleeve Restrained and Nonrestrained Couplings for Plain – End:
    - a. In accordance with AWWA C227.
    - b. Refer to Section 33 21 95 – Metal Piping for Line Pipe for coupling requirements.
- L. Tees:
  - 1. Tees for air valves, blowoffs, manholes, and temporary construction line as shown on drawings.
  - 2. Tee length, minimum: As shown on drawings, required for blocking, or in accordance with AWWA C208 whichever is greater

### **2.03 LININGS AND COATINGS**

- A. In accordance with Section 09 96 20 – Coatings.
- B. Do not field apply mortar lining without OGR approval.

### **2.04 CONCRETE**

- A. Concrete in Thrust Blocks and Collars: Section 03 30 00 – Cast-in-Place Concrete.

### **2.05 FLANGES:**

- A. In accordance with AWWA C207.
- B. Class: Working pressure meets or exceeds head class of attached pipe

### **2.06 FLANGE GASKETS:**

- A. BLUE-GARD Style 3000 manufactured by Garlock Sealing Technologies, 1666 Division Street, Palmyra NY 14522, or equal, having the following essential characteristics:
  - 1. Sized in accordance with AWWA C207, Table 1.
  - 2. For AWWA C207 flanged joints.
  - 3. Compressed, Non-Asbestos (CNA) Gasketing with Aramid Fibers and a NGR Binder.
  - 4. For potable cold-water service.

### **2.07 CONTRACTOR SOURCE QUALITY TESTING**

- A. Pipe and Fittings:
  - 1. Hydrostatic Test:
    - a. Perform shop hydrostatic test on pipe which stresses steel to 75 percent of minimum yield point of the steel.
    - b. Hold pressure long enough to allow thorough inspection of welded joints.
    - c. Repair leaks by rewelding and retesting joints.
    - d. Test sections prior to forming bell and spigot joints.
    - e. Repair defects and retest section before applying lining and coating.
    - f. Government may witness hydrostatic testing and calibration of pressure gauges. Notify Government 30 days prior to performing hydrostatic test.
  - 2. Fittings fabricated from tested steel pipe do not require hydrostatic testing if welds are tested.
    - a. Weld test: Dye penetrant test in accordance with ASTM E165 or Magnetic Particle in accordance with ASTM E709.
    - b. Weld defect repair. Chip, flame gouge, or grind to sound metal; reweld; and test repaired weld.

- B. Joint Testing: Assemble one joint for each pipe diameter to check bell and spigot to check fit prior to coating or lining.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Joining Pipe:
  - 1. In accordance with AWWA C604.
  - 2. Verify inside joint gap meets manufacturer's tolerances as work progresses.
- B. Joints for Pipe with Welded Joints:
  - 1. In accordance with AWWA C206. Welded joints after backfill not allowed.
  - 2. Perform dye penetrant test on welds in accordance with ASTM E165.
  - 3. Welded Butt Joints:
    - a. As required for pipe on steep slopes as shown on drawings.
  - 4. Double Lap Weld Joints:
    - a. Provide joint with full fillet welds.
    - b. Air test double lap welds in accordance with AWWA C206.
    - c. Required on thrust restrained joints greater than 30 degree bend deflection angles, unless butt welded joints are required.
  - 5. Single Lap Weld Joints:
    - a. May be used on thrust restrained joints with 30 degree bend deflection angles or less.
    - b. Road and wash crossings unless butt or double-lap welded joints are required.
  - 6. Joint Thrust Restraint: As shown on drawings.
- C. Connections at Thrust Blocks and Structures: As shown on drawings
- D. Closure Sections:
  - 1. Where necessary as determined by Contractor, subject to approval of OGR.
  - 2. Ambient temperature when closure section is welded, maximum: 60 degrees F.

### **3.02 TOLERANCES**

- A. Lay pipe to lines and grades shown on drawings or established by OGR to following tolerances:
  - 1. Total departure from established alignment and grade, maximum: 1-inch.

### **3.03 ADJUSTMENTS IN ALIGNMENT AND GRADE FOR PULLED JOINTS**

- A. Per approved pipe laying diagrams.
- B. Refer to Section 33 11 10 – Pipeline General Requirements.
- C. Make small minor changes in alignment and grade by providing small deflections between adjacent pipe sections as follows:
  - 1. Pulling rubber gasket bell-and-spigot joint:
    - a. A total 1-inch joint deflection may be permitted by reducing normal 1/2-inch inside mortar space to 1/4-inch and pulling opposite side of pipe 3/4-inch from normal closure.
    - b. Provide unsymmetrical closure at welded lap joint up to maximum pullout of 1-inch.
  - 2. Maximum deflection angle between adjacent pipe sections: Manufacture's recommendations but shall not exceed 5 degrees.
- D. Lay ends of each section of steel line pipe on theoretical centerline of curve and to grade shown on drawings within laying tolerances prescribed above.

### **3.04 JOINT LINING AND COATING**

- A. Field joints for pipe with shop applied cement-mortar lining.
  - 1. Line field joints with cement-mortar in accordance with AWWA C205.
  - 2. Coat exterior joints as specified in Section 09 96 20 – Coatings.
  - 3. Do not backfill field joints until coating is approved by OGR.
- B. Apply shrink sleeves to field joints in accordance with Section 09 96 20 – Coatings.

### **3.05 BACKFILL**

- A. Keep internal supports in place until embedment has been placed and compacted above bottom of pipe to minimum height of 0.7 times diameter.

### **3.06 PIPE DIAMETER DEFLECTION**

- A. Allowable short-term vertical pipe diameter deflection after backfilling is complete.
  - 1. Decrease, maximum: 2 percent of nominal pipe diameter.
  - 2. Elongation, maximum: 3 percent of nominal pipe diameter as measured when backfill reaches pipe crown.
  - 3. Short term is within 2 weeks after backfilling is complete.
- B. Allowable long-term vertical pipe diameter deflection, at end of warranty period:
  - 1. Decrease, maximum: 3 percent of nominal pipe diameter.

**END OF SECTION**

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**SECTION 33 11 15****PVC PIPE DRAINS****PART 1 GENERAL****1.01 MEASUREMENT AND PAYMENT****A. PVC Pipe Drains *for Water Storage Tank*:**

1. Measurement: Length of installed drain measured along pipe centerline with no allowance for joints.
2. Payment: ~~Unit price~~ Price per linear foot offered in Price Schedule 7 (Pumping Plant No. 7).

**1.02 REFERENCE STANDARDS****A. ASTM International (ASTM)**

- |    |                  |  |
|----|------------------|--|
| 1. | ASTM C33/C33M-16 | Concrete Aggregates  |
| 2. | ASTM D1785-15    | Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120    |
| 3. | ASTM D2103-15    | Polyethylene Film and Sheeting                                       |
| 4. | ASTM D2466-15    | Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40         |
| 5. | ASTM D2564-12    | Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems |

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 33 11 15-1, Certification:
  1. Submit manufacturer's certification that pipe meets specified requirements.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Store and handle pipe in accordance with manufacturer's recommendations.
- B. Do not use rope, cable, or chain slings to handle drain pipe. Fabric slings not less than 12-inches in width may be used to handle drain pipe.

## **PART 2 PRODUCTS**

### **2.01 PVC DRAIN AND VENT PIPE**

- A. Solid and Slotted PVC Pipe: ASTM D1785, Schedule 40.
- B. Slotted Pipe Slots:
  - 1. Width: 0.125-inch.
  - 2. Spacing: 0.25-inch.
  - 3. Open Area: 35.7-inches, minimum, per foot of pipe.
- C. Joining System: Solvent cement joints.

### **2.02 FILTER MATERIAL**

- A. ASTM C 33, Size No. 6 (3/4- to 3/8-inch).

### **2.03 ACCESSORIES**

- A. Pipe Fittings: ASTM D2466.
- B. Solvent Cement: ASTM D2564.
- C. Polyethylene Sheeting:
  - 1. ASTM D2103.
  - 2. Thickness: 6 mils, minimum.

## **PART 3 EXECUTION**

### **3.01 DRAIN PIPE INSTALLATION**

- A. Solvent weld joints in accordance with manufacturer's recommendations.
- B. Place and tamp filter material about drain pipe to hold pipe securely in position while overlying material is placed.
- C. Cover filter material with polyethylene sheeting where indicated on drawings:
  - 1. Place sheeting to form barrier between filter and fresh concrete so that concrete mortar does not enter filter material.
  - 2. Lap sheets 6-inches, minimum, at joints between sheets.
- D. Keep pipe interior free of dirt, filter material, and foreign material. Provide temporary closure at open pipe ends during work shutdown.

**3.02 AIR VENT INSTALLATION**

- A. Embed pipe in concrete structure as indicated on drawings.
- B. Solvent weld joints in accordance with manufacturer's recommendations.
- C. Maintain in correct position and alignment during concrete placement.
- D. Keep pipe interior free of dirt, concrete, and foreign material.

**3.03 CLEANING**

- A. Clean or replace drains that become clogged, damaged, or obstructed from any cause before acceptance of work. Use methods approved by COR to clean or replace pipe.

**3.04 PROTECTION**

- A. Protect drain pipe from vehicular and equipment traffic during installation.

**END OF SECTION**

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**SECTION 33 11 16**  
**SITE WATER UTILITY PIPING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Site Water Utility Piping:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |                    |  |
|----|--------------------|--|
| 1. | ASTM D882-12       | Standard Test Method for Tensile Properties of Thin Plastic Sheeting   |
| 2. | ASTM D1785-15      | Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120   |
| 3. | ASTM D2103-10      | Standard Specification for Polyethylene Film and Sheeting  |
| 4. | ASTM D2464-15      | Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80   |
| 5. | ASTM D2467-15      | Standard Specification for Poly (Vinyl Chloride) Plastic Pipe Fittings, Schedule 80  |
| 6. | ASTM D2855-15      | Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets |
| 7. | ASTM C33/C33M-16e1 | Concrete Aggregates  |

B. Chlorine Institute (CI)

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|----|----------------|----------------------------|
| 1. | CI Pamphlet 96 | Sodium Hypochlorite Manual |
|----|----------------|----------------------------|

C. American Water Works Association (AWWA)

- |    |              |   |
|----|--------------|---|
| 1. | AWWA C605-13 | Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water |
|----|--------------|---|



D. RSN 33 11 16-3, Final Drawings and Data:

1. As-built drawings: 11- x 17-inch.
2. Pressure leak test report.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle equipment and components in accordance with manufacturer's recommendations to prevent damage.

**PART 2 PRODUCTS**

**2.01 PIPING, TUBING, AND FITTINGS**

A. Plastic pipe and fittings:

1. ASTM D1785.
2. Solution:
  - a. Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
  - b. Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
3. Material:
  - a. NSF/ANSI 14 and 61.
  - b. Schedule 80 PVC.
4. Sizes:
  - a. 1/2-inch.
  - b. 1-inch.
  - c. 2-inch.
5. Connections: Socket weld with Weld-On 724 CPVC glue by Weld-On Adhesives, Inc., 455 West Victoria Street, Compton, California, 90220, or equal.
6. Expansion joints: Model number SL-50 by Red Valve Company, Inc., 600 North Bell Avenue, Carnegie, Pennsylvania, 15106, or equal, with the following essential characteristics:
  - a. Material: Viton.
  - b. Working pressure: 75 psi.

B. Plastic electrical conduit and fittings:

1. ASTM D1785.
2. Solution: None, carrier pipe for PTFE tubing.
3. Material: Schedule 40 PVC.

4. Size: 1 1/2-inch.
  5. Connections: Socket weld.
  6. Elbows: Long-sweep.
  7. Expansion joints: Model number XJ by Fernco, Inc., 300 South Dayton Street, Davison, Michigan, 48423, or equal, with the following essential characteristics:
    - a. Material: Ethylene propylene diene monomer (EPDM) or Viton.
    - b. Working pressure: 4 psi.
- C. Plastic tubing and fittings:
1. Solution:
    - a. Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
    - b. Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  2. Material:
    - a. NSF/ANSI 14 and 61.
    - b. Tubing:
      - 1) PTFE.
      - 2) PVC.
    - c. Fittings:
      - 1) Polypropylene (PP) for PTFE tubing.
      - 2) Schedule 80 PVC for PVC tubing.
  3. Size:
    - a. 3/8-inch OD x 1/4-inch ID for PTFE tubing.
    - b. 1-inch for PVC tubing.
  4. Connections:
    - a. 3/8-inch OD compression fittings.
    - b. 1-inch Schedule 80 PVC barb x thread with 316 SS hose clamps.
- D. Metallic warning tape:
1. Compliant with ASTM D882 and ASTM D2103.
  2. Standard 6-inches wide, commercial quality, detectable underground warning tape.
  3. Continuous tape with message "Caution Buried Waterline Below."
  4. Color: NTUA Blue.

## **2.02 VALVES**

- A. Plastic ball and ball check valves:
  - 1. Solution:
    - a. Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
    - b. Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  - 2. Material:
    - a. NSF/ANSI 14 and 61.
    - b. Schedule 80 PVC.
    - c. Viton or PTFE O-rings and seals.
  - 3. Sizes:
    - a. 1/2-inch.
    - b. 1-inch.
    - c. 2-inch.
  - 4. True-union.
  - 5. Vented ball valves.

## **2.03 PIPE SLEEVES**

- A. Purpose: PVC pipe protection under Chemical Building foundation.
- B. Pipe sleeves:
  - 1. Size: 4-inches.
  - 2. Material: Epoxy-coated steel or 316 SS pipe.
  - 3. Through-pipe sizes:
    - a. Schedule 80 PVC pipe, 1-inch.
    - b. Schedule 40 PVC electrical conduit, 1 1/2-inch.

## **2.04 PIPE TRENCH BEDDING AND BACKFILL**

- A. Bedding: ASTM C33, coarse sand 100 percent passing 3/8-inch screen and 95 percent passing No. 4 screen.
- B. Backfill: Per Section 31 23 02 – Compacting Earth Materials.

## **2.05 PIPE INSULATION**

- A. Purpose: Insulation of Lines 19, 21, and 25 between bottom of pipe trench and tank-mounted enclosure (see drawing number 1695-D-60476).

**B. Insulation:**

1. Commercially available.
2. Minimum 2-inch wall thickness.
3. Flexible elastomeric with adhesive-backed connection.
4. Minimum R-value: 13
5. UV and moisture resistant.
6. Aluminum jacketed.

**C. Through-pipes:**

1. 1 1/2-inch schedule 40 PVC electrical conduit.
2. 1-inch schedule 80 PVC pipe inside 2-inch schedule 80 PVC pipe sleeve.

**PART 3 EXECUTION****3.01 INSTALLATION****A. Laying of pipe:**

1. Install water pipes in conformity with approved design plan and in coordination with COR.
2. Clean each section of pipe and each fitting before installation.
3. Lower pipe and fittings into trench preventing damage to pipe. Use approved slings when required.
4. Lay pipe true and uniform to line and grade, with no visible change in alignment at any joint unless curved alignment is called for on plans. If deflection is required, maximum deflection must not exceed manufacturer's recommendation for type of pipe and joint being used.
5. Whenever pipe laying is discontinued for 1-hour or more, close open ends of pipe with water-tight plugs.
6. Pipe shall not be laid when condition of trench or weather is unsuitable or when there is possibility of foreign material entering pipe.

**B. Joining methods:**

1. Socket weld.
2. PVC NPT adapters for connections to metallic components.

**C. Install equipment as shown in the following drawings:**

1. 1695-D-60476.
2. 1695-D-60487.
3. 1695-D-60489.

- D. Chlorination line transitions at Storage Tank S0501-TK-001 wall (in direction of flow):
1. Outside of tank (within heated enclosure):
    - a. Line 25: 3/8-inch OD PTFE tubing to 1/2-inch Schedule 80 PVC piping.
    - b. Line 21: 1/2-inch Schedule 80 PVC piping to 3/8-inch OD PTFE tubing.
    - c. Line 19: 1-inch Schedule 80 PVC piping to 1-inch PVC tubing to 1-inch Schedule 80 PVC piping. PVC tubing purpose is to prevent pipe breakage during Storage Tank S0501-TK-001 settlement.
    - d. Spare tank wall penetration: 1/2-inch Schedule 80 PVC piping, valve normally closed (NC) and piping capped.
  2. Inside of tank:
    - a. Line 25: 1/2-inch Schedule 80 PVC piping protruding 6-inches into Storage Tank S0501-TK-001 to 3/8-inch OD PTFE tubing to within 6-feet of treated water storage tank mixer, attached to fiberglass reinforced plastic (FRP) channel stand mounted to Storage Tank S0501-TK-001 floor.
    - b. Line 21: 1/2-inch Schedule 80 PVC piping protruding 1-foot into Storage Tank S0501-TK-001. Screen pipe end using 316 SS mesh screen, No. 20 standard mesh size.
    - c. Line 19: 1-inch Schedule 80 PVC piping protruding 2-inches into Storage Tank S0501-TK-001.
    - d. Spare tank wall penetration: 1/2-inch Schedule 80 piping protruding 6-inches into Storage Tank S0501-TK-001.

### **3.02 EARTHWORK AND TRENCHES**

- A. Pipe bedding and backfill:
1. Minimum 4-inch sand bedding below piping, hand tamped to spring line of pipe.
  2. Minimum 36-inches compacted backfill. Place backfill in even layers not exceeding 6-inches in depth and compacted, before proceeding to next layer.
  3. Minimum 6-inches of gravel above compacted backfill.
- B. Metallic detectable warning tape: Lay continuous metallic warning tape above runs of nonmetallic pipe to facilitate locating pipe at later date.

### **3.03 COMPONENTS**

- A. Expansion joints: Install on all PVC pipe within 2-feet of Chemical Building.
- B. Pipe sleeves: Install 4-inch diameter, 2-foot segments around all PVC pipe under Chemical Building foundation.

- C. Pipe insulation: Install on Lines 19, 21, and 25 between ground and tank-mounted enclosure.

### **3.04 CONTRACTOR FIELD QUALITY TESTING**

- A. Using potable water, perform operating tests to assure that sodium hypochlorite feed system operates properly in accordance with manufacturer's instructions.
- B. Test PVC pressure pipe and PTFE tubing by the following:
  - 1. Furnish testing equipment, as approved by COR, which provides observable and accurate measurements of leakage under specified conditions.
  - 2. Maximum Filling Velocity: 0.25-foot per second calculated based on full area of pipe.
  - 3. Expel air from piping system during filling.
  - 4. Test pressure: 150 percent of system operating pressure based on pressure as measured at lowest point on line. Maximum test pressure not to exceed 150-psi. Test pressure for some segments may be reduced, subject to COR approval.
  - 5. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
  - 6. Maintain hydrostatic test pressure continuously for 2-hours minimum.
  - 7. Maximum allowable leakage: None, as measured by pressure drop.
- C. If any deficiencies are revealed during any tests, such deficiencies shall be corrected, and tests shall be repeated.

### **3.05 DISINFECTION OF WATER SUPPLY LINE**

- A. Disinfect water lines per Section 22 11 10 – Plant Auxiliary Water Systems.

**END OF SECTION**

**SECTION 33 11 17**  
**PVC PRESSURE PIPE**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. In accordance with Section 33 11 10 – Pipeline General Requirements.

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |               |  |
|----|---------------|--|
| 1. | ASTM C923-18  | Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals  |
| 2. | ASTM F1674-18 | Joint Restraint Products for Use with PVC Pipe   |
| 3. | ASTM F2510-17 | Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes |

B. American Water Works Association (AWWA)

- |    |              |  |
|----|--------------|--|
| 1. | AWWA C605-13 | Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings |
| 2. | AWWA C110-12 | Ductile-Iron and Gray-Iron Fittings for Water  |
| 3. | AWWA C111-17 | Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings   |
| 4. | AWWA C900-16 | Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-In. through 60-In. (100 mm through 1,500 mm)                     |

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.

- B. RSN 33 11 17-1, Shop Drawings:
1. Show pipe and fitting fabrication details. Include:
    - a. Lengths of pipe, joint type and overlap lengths, restrained lengths, inside pipe diameters and dimension ratios.
  2. Dimensions of joints, diameter of rubber gasket including tolerances, other major dimensions, proposed restraint, and location which include station and elevation.
  3. Connections details to other pipe types (coupling information and dimensions).
  4. See RSN 33 11 10-2 for further details.
- C. RSN 33 11 17-2, Pipe Manufacture Certification:
1. Pipe meet AWWA C900.

#### **1.04 GENERAL**

- A. In accordance with applicable portions of Section 33 11 10 – Pipeline General Requirements.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Provide sun protection for PVC pipe stored outside.
1. At minimum, wrap pipe with fastened opaque covering.
  2. In warm climates, allow air circulation through and around pipe by puncturing or cutting covering in area of pipe ends.

### **PART 2 PRODUCTS**

#### **2.01 PIPE**

- A. PVC Pressure Pipe: AWWA C900: Elastomeric joint or fused joints where shown on drawings:
1. Nominal laying length: 18-feet.
  2. PVC pipe dimensions: Based on AWWA Cast Iron (CI) sizes for diameters.
  3. Minimum Pressure Rating of Pipe: Higher pressure rating from the following requirements:
    - a. Pressure defined by steady state Hydraulic Grade Line as shown on pipeline plan and profile drawings.
    - b. Transient pressure defined by pipe head class as shown on pipeline plan and profile drawings shall not be greater than 10 percent of continuous pressure rating of pipe.
- B. Rubber Gaskets: Manufactured and tested in accordance with AWWA C900.

## 2.02 FITTINGS

### A. Allowable:

1. Steel: In accordance with Section 33 11 12 – Steel Line Pipe.
2. Ductile Iron Fittings:
  - a. AWWA C110 and C111.
  - b. Coatings and Lining:
    - 1) Refer to Section 09 96 20 – Coatings.
    - 2) Cement mortar lining: Double thickness as defined by AWWA C104.
  - c. Tees, Bends, or Adaptors:
    - 1) Lengths: AWWA C110 or as shown on drawings.
    - 2) Ends: Fit type of joint in adjacent pipeline.
  - d. Plan, profile and restraint system shown on drawings require modification if ductile iron fittings are used.

### B. Rubber Gaskets: Manufactured and tested in accordance with AWWA C605.

### C. Joint Restraint Products: ASTM F1674:

1. Joint Restraint:
  - a. Not allowed where thrust restraint requires more than 2 pipe joints:
    - 1) Maximum, 2 PVC restrained pipe joints allowed each side of miter bend.
  - b. Allowed for road and wash crossings where thrust restraint limitation is not reached.
2. Between pipe sections:
  - a. Megalug Series, EBAA Iron Sales, Incorporated, P.O. Box 857, Eastland TX 76448, telephone: 800-433-1716 [www.ebaa.com](http://www.ebaa.com) or equivalent
3. Between pipe and fittings:
  - a. Megalug Series, EBAA Iron Sales, Incorporated, P.O. Box 857, Eastland TX 76448, telephone: 800-433-1716 [www.ebaa.com](http://www.ebaa.com) or equivalent
4. End of pipe:
  - a. Megalug Series 2100, EBAA Iron Sales, Incorporated, P.O. Box 857, Eastland TX 76448, telephone: 800-433-1716 [www.ebaa.com](http://www.ebaa.com) or equivalent.

- D. Flexible Pipe to Concrete Structure: ASTM C923 and F2510
  - 1. Pumping Plant 4 Tank Drain Baffled Outlet:
    - a. A-LOK Premium Connector, A-LOK Products, Incorporated, 697 Main Street, Tullytown PA 19007, telephone: 215 547 3366 a-lok.com or equivalent.

### **2.03 CONTRACTOR SOURCE QUALITY TESTING**

- A. PVC Pipe: AWWA C900:
  - 1. Tests may be witnessed by Government. Notify OGR 30-days prior to testing.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. In accordance with applicable portions of Section 33 11 10 – Pipeline General Requirements.

### **3.02 JOINING PIPE**

- A. Join pipe in accordance with AWWA C605 or as directed by OGR.
- B. Apply firm, steady pressure either by hand or using bar and block until spigot easily slips through gasket. Mechanical equipment such as come-alongs may be used to join pipe.
- C. Spigot end of pipe: Marked by manufacturer to indicate proper depth of insertion.
- D. Push spigot until reference mark on spigot end is flush with bell end.
- E. Connections between PVC Pressure Pipe and Other Types of Pipe: Use rubber gasketed mechanical joints to make connections.
- F. Cathodic protection required for metallic miter bends and metallic joint restraint.

### **3.03 ADJUSTMENTS IN ALIGNMENT AND GRADE FOR PULLED JOINTS**

- A. Make small adjustments in alignment and grade by providing deflections at joints:
  - 1. Maximum Deflection: 1 degree or deflection recommended by pipe manufacturer, whichever is less.
- B. Longitudinal bending of pipe to obtain deflection: Not permitted.
- C. Other methods of providing curves in pipelines may be submitted. If approved, use these methods to install curves.

**3.04 TOLERANCES**

- A. Lay pipe to lines and grades shown on drawings or as established by COR with the following tolerances:
1. Total departure from established alignment and grade, maximum: 1-inch.

**3.05 PIPE DIAMETER DEFLECTION**

- A. Allowable short term vertical pipe diameter deflection after backfilling is complete:
1. Decrease, maximum: 4 percent of nominal pipe diameter.
  2. Elongation, maximum: 3 percent of nominal pipe diameter as measured when backfill reaches pipe crown.
- B. Allowable long-term vertical pipe diameter deflection, at end of warranty period:
1. Decrease, maximum: 5 percent of nominal pipe diameter.

**END OF SECTION**

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**SECTION 33 12 71**  
**VERTICAL PUMPING UNITS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Vertical Pumping Units:

1. Payment: Lump sum prices offered in the Price Schedules:
  - a. Furnish, install, and test:
    - 1) Pumping Plant No. 4 pumping units, four (4) pumping units.
    - 2) Pumping Plant No. 7 pumping units, four (4) pumping units.

**1.02 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI B1.20.1-13 Pipe Threads, General Purpose, Inch

B. American Society of Mechanical Engineers (ASME)

1. ASME BPVC-IX-19 Boiler and Pressure Vessel Code – Section IX – Welding, Brazing and Fusing Qualifications

C. American Society of Civil Engineers

1. ASCE 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures

D. ASTM International (ASTM)

1. ASTM A36/A36M-19 Carbon Structural Steel
2. ASTM A48/A48M-03(16) Gray Iron Castings
3. ASTM A53/A53M-18 Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless
4. ASTM A105/A105M-18 Carbon Steel Forgings for Piping Applications
5. ASTM A106/A106M-19a Seamless Carbon Steel Pipe for High-Temperature Service
6. ASTM A181/A181M-14 Carbon Steel Forgings, for General-Purpose Piping
7. ASTM A216/216M-18 Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

- |     |   |  |
|-----|---|--|
| 8.  | ASTM A276/A276M-17                      | Stainless-Steel Bars and Shapes  |
| 9.  | ASTM A283/A283M-18                      | Low and Intermediate Tensile Strength Carbon Steel Plates  |
| 10. | ASTM A285/A285M-17                      | Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength                           |
| 11. | ASTM A516/A516M-17                      | Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service                      |
| 12. | ASTM A536/A536M-84(19)e1                | Ductile Iron Castings  |
| 13. | ASTM A564/564M-19a                      | Hot-Rolled and Cold-Finished Age-Hardening Stainless-Steel Bars and Shapes                             |
| 14. | ASTM A572/A572M-18                      | High-Strength Low-Alloy Columbium-Vanadium Structural Steel  |
| 15. | ASTM A582/A582M-12(17)                  | Free-Machining Stainless-Steel Bars  |
| 16. | ASTM A709/A709M-18                      | Structural Steel for Bridges   |
| 17. | ASTM A744/A744M-13                      | Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service                                |
| 18. | ASTM E10-18                             | Test Method for Brinell Hardness of Metallic Materials   |
| E.  | American Water Works Association (AWWA) |  |
| 1.  | AWWA C207-18                            | Steel Pipe Flanges for Waterworks Service, Sizes 4 In. through 144 In.                                 |
| 2.  | AWWA E103-15                            | Horizontal and Vertical Line-Shaft Pumps   |
| F.  | American Welding Society (AWS)          |  |
| 1.  | AWS D1.1/D1.1M-15(16)                   | Structural Welding Code - Steel  |
| G.  | Hydraulic Institute Standards (HI)      |  |
| 1.  | HI 9.2-15                               | Pumps – General Guidelines for Types, Applications, Definitions, Sound Measurements, and Documentation |
| 2.  | HI 9.6.1-17                             | Rotodynamic Pumps – Guidelines for NPSH Margin   |
| 3.  | HI 9.6.3-17                             | Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region                |
| 4.  | HI 9.6.4-16                             | Centrifugal and Vertical Pumps – Vibration Measurements and Allowable Values                           |

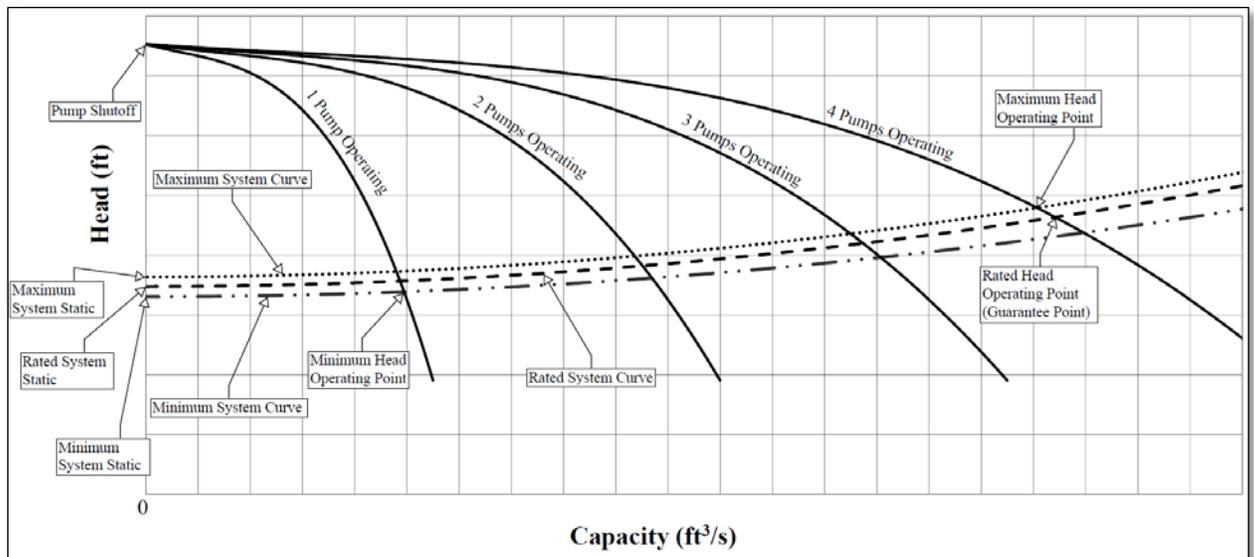
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|------|--|---|
| 5.   | HI 9.6.8-14  | Rotodynamic Pumps – Guideline for Dynamics of Pumping Machinery                                 |
| 6.   | HI 9.8-18  | Intake Design for Rotodynamic Pumps   |
| 7.   | HI 14.1-2.2-19   | Rotodynamic Pumps for Nomenclature and Definitions  |
| 8.   | HI 14.3-19   | Rotodynamic Pumps for Design and Application  |
| 9.   | HI 14.6-16   | Rotodynamic Pumps for Hydraulic Performance Acceptance Tests                                    |
| <br> |  |   |
| H.   | Institute of Electrical and Electronics Engineers (IEEE) |   |
| 1.   | IEEE 112-04  | Test Procedure for Polyphase Induction Motors and Generators                                    |
| <br> |  |   |
| I.   | International Standard Organization (ISO)                |   |
| 1.   | ISO 21940-11:2016  | Mechanical vibration. Rotor balancing. Procedures and tolerances for rotors with rigid behavior |
| <br> |  |   |
| J.   | National Electrical Manufacturers Association (NEMA)     |   |
| 1.   | NEMA MG 1-16   | Motors and Generators   |
| <br> |  |   |
| K.   | NSF International (NSF)                                  |   |
| 1.   | NSF 61-19  | Drinking Water System Components - Health Effects   |

### **1.03 DEFINITIONS**

- |    |  |
|----|--|
| A. | AOR: Allowable Operating Region.   |
| B. | BEP: Best Efficiency Point.  |
| C. | POR: Preferred Operating Region.   |
| D. | Pump Bowl Assembly: Suction bell, bowls, impellers, shaft, bearings, discharge case, and complete associated internal components.              |
| E. | Pump: Pump bowl assembly, head shaft, drive shaft, column pipe, spiders, line shaft, line shaft bearings, discharge head, and mechanical seal. |
| F. | Pumping Unit: Complete pump and motor assembly.  |
| G. | NPSHA: Net Positive Suction Head Available.  |
| H. | NPSHR: Net Positive Suction Head Required.   |
| I. | Brinell hardness (BHN): A measure of the resistance to indentation of a material, as defined in ASTM E10.                                      |

- J. RCF: Reed Critical Frequency
- K. RTD: Resistance Temperature Detector.
- L. Special Tools: Tools not commercially available from tool suppliers but are necessary for the assembly, disassembly, or adjustment of equipment.

Figure 33 12 71 – Pump and System Curve Definitions



**Minimum Head Operating Point:** Pump head and flow where minimum system curve intersects pump curve with one pump operating. See Figure 33 12 71 – Pump and System Curve Definitions.

- N. **Maximum Head Operating Point:** Pump head and flow where maximum system curve intersects pump curve with four pumps operating in parallel. Assume equal flow from each pump operating in parallel. See Figure 33 12 71 – Pump and System Curve Definitions.
- O. **Range of Total Heads:** Range of pump total heads from minimum head operating point to maximum head operating point.
- P. **Rated System Curve:** System capacity and head curve defined by points: Rated static head at zero capacity and the rated total head at four times capacity per unit at rated total head. Data defining rated system curve defined in Table 33 12 71A – Performance Requirements. See Figure 33 12 71 – Pump and System Curve Definitions.
- Q. **Maximum System Curve:** System capacity and head curve defined by points: the maximum system static head at zero capacity and the maximum system head at the system capacity at maximum system head. Data defining maximum system curve defined in Table 33 12 71B – Maximum System Curve. See Figure 33 12 71 – Pump and System Curve Definitions.

- R. Minimum System Curve: System capacity and head curve defined by points: Minimum system static head at zero capacity and minimum system head at system capacity at minimum system head. Data defining minimum system curve defined in Table 33 12 71C – Minimum System Curve. See Figure 33 12 71 – Pump and System Curve Definitions.

#### 1.04 SYSTEM DESCRIPTION

##### A. Design Requirements:

1. Vertical rotodynamic pump, complete with all accessories and special tools, suitable for connection to the vertical induction motor.
2. Four (4) equally sized units at each pumping plant designed to operate with 1 to 4 pumps in parallel. Rated total head and capacity is defined in Table 33 12 71A - Performance Requirements. Rated total head and capacity and static head in Table 33 12 71A – Performance Requirements is for the condition of 4 pumps operating in parallel from tank normal water surface elevation to tank normal water surface elevation and with no flow diverted to turnouts along pipeline.
3. Design and construct pump in accordance with HI 14.1 - 14.3, HI 9.6.4, HI 9.8, and AWWA E103; except as modified herein.
4. Weight of pump rotating parts, including unbalanced hydraulic thrust of impeller(s), to be carried by motor thrust bearing. Rotation may be in either direction.
5. Pumping unit to be suitable for operation at an elevation of 5,867.50 feet at Pumping Plant No. 4 and 6,215.00 feet at Pumping Plant No.7 and with ambient air temperatures between 32 to 104 degrees F.
6. Design pump bowls, column pipe, and discharge head for working pressure equivalent to or greater than pump shutoff head.
7. Barrel intake with suction below deck and pump discharge above deck as shown on drawings.
8. Design pump to start and stop against closed discharge valve and to operate satisfactorily over expected range of total heads.
9. Pump construction NSF 61 certified and covers all wetted parts of pump.
10. Pumped liquid is treated potable drinking water with maximum of 4 parts per million of free chlorine at a temperature between 33- and 80-degrees F.
- ~~11. Design pump and motor to pass through roof hatch located over each pumping unit for installing and removal.~~
12. Design pump to operate safely at maximum runaway speed due to water returning through pump when power to motor is interrupted and check valve fails to close. Determine maximum runaway speed using maximum head listed in Table 33 12 71A - Performance Requirements.

13. Pumping units shall be seismically restrained to meet ASCE 7 Chapter 13 – Seismic Design Requirements for Nonstructural Components. Seismic design criteria are shown on drawing 1695-D-60399. Designs shall be performed by a Registered Professional Engineer registered in one of the 50 States of the United States or the District of Columbia ~~Professional Engineer licensed to practice in the state of New Mexico.~~

B. Performance Requirements:

1. Components of pumping unit and barrel intake must be supplied by one manufacturer including, but not limited to, suction pipe welded to barrel and barrel, barrel vanes, bowl assemblies, column, shafting, discharge head, sole plate, shaft couplings, seals, and motors.
2. Pump performance requirements listed in Table 33 12 71A – Performance Requirements.
3. Pump performance and design requirements shall be at motors full load speed for specified voltage and frequency unless otherwise specified.
4. Internal pump and bell entrance losses are not included in “rated total head” column shown in Table 33 12 71A – Performance Requirements.
5. Select pump with a head-capacity curve that has a continuously rising head with decreasing capacity from minimum expected head to shutoff head.
6. Select pumping unit with manufacturer’s required submergence less than submergence available.
7. Minimum estimated hydraulic grade line elevation at the barrel inlet (losses from inlet of barrel to pump intake bell are not included):
  - 1) Pumping Plant 4: 5,874.34 ft.
  - 2) Pumping Plant 7: 6,222.80 ft.
8. Select pumps to operate in the allowable operating region (AOR) and preferred operating region (POR) as defined by HI 9.6.3 over range of total heads.
9. Net positive suction head (NPSH) margin in accordance with HI 9.6.1 requirements for water/wastewater pumps NPSH margin ratio and a minimum NPSH margin of 5-feet over the expected range of total operating heads. Calculate NPSH available at first stage datum based on minimum estimated hydraulic grade line elevation at barrel inlet.
10. Shutoff head shall not exceed 450-psi for pumping units as determined by shop performance testing of each pumping unit.
11. Perform motor reed critical frequencies calculations and minimum of Level 1 lateral, torsional, and structural dynamic analyses in accordance with HI 9.6.8 Rotodynamic Pumps Guideline for Dynamics of Pumping Machinery.

Table 33 12 71A – Performance Requirements

Pumping Units	Pumping Plant No. 4 (Units 1, 2, 3, and 4)	Pumping Plant No. 7 (Units 1, 2, 3, and 4)
Capacity per unit at rated total head (ft <sup>3</sup> /sec)	11.925	10.1
Rated total head (ft)	523	577
Rated static head (ft)	347.5	484
Maximum allowable speed (revolutions per minute)	1800	1800
Minimum pump efficiency at rated total head (percent)	74	74
Head for sustained reverse speed calculation (ft)	363.5	500

Table 33 12 71B – Maximum System Curve

Pumping Units	Pumping Plant No. 4 (Units 1, 2, 3, and 4)	Pumping Plant No. 7 (Units 1, 2, 3, and 4)
System capacity at maximum system head (ft <sup>3</sup> /sec)	47.7	40.40
Maximum system head (ft)	545	589
Maximum system static head (ft)	363.5	500

Table 33 12 71C – Minimum System Curve

Pumping Units	Pumping Plant No. 4 (Units 1, 2, 3, and 4)	Pumping Plant No. 7 (Units 1, 2, 3, and 4)
System capacity at minimum system head (ft <sup>3</sup> /sec)	47.7	40.40
Minimum system head (ft)	483	556
Minimum system static head (ft)	330.5	470

## 1.05 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittals.
- B. RSN 33 12 71-1, Approval Data and Drawings:
  1. Pumps:
    - a. Complete commercial products data including manufacturer's name, type, model, size, specification and dimensions. Include technical data and procedures demonstrating conformance with these specifications.

- b. Drawings and data:
    - 1) Pumping unit dimensional drawings for specific job assembly.
    - 2) Sectional assembly drawings with parts and materials of construction, dimensions, total pump weight, total bowl assembly weight, and major component weights, column section length and means of assembly.
  - c. Complete pump performance curves showing capacity versus head, efficiency, horsepower, total dynamic head, and NPSHR with reference to capacity and operating speed. Indicate rated condition and allowable operating range on pump curves.
  - d. Pump curves for 1 to 4 pumps operating in parallel showing capacity versus head. Include rated condition system curve, maximum head system curve, and minimum head system curve.
2. Pumping Unit Performance Test Procedure, including:
- a. Shop test set up drawing with dimensions.
  - b. Calculations for each pump at the specified rated condition at full motor speed showing how pump performance will be calculated from pump test data.
  - c. Process instrumentation location, elevation, and configuration.
  - d. Capacity and expected head of the eight test points specified in these specifications.
  - e. Rated speed of pump at guarantee point.
3. Pumping Unit Installation Procedures, including:
- a. Detailed pumping unit and motor field alignment procedures.
  - b. Detailed pump lubrication installation requirements.
  - c. Detailed pump assembly and installation requirements. Should include drawing with lifting lug location, capacity, and suggested rigging.
4. Pump Pre-Installation and Storage Maintenance Instructions, including:
- a. Equipment protective covering and storage requirements during storage period following delivery prior to installation.
  - b. Equipment rotation and maintenance requirements to prevent shaft bending, component warping, and equipment damage during storage period.
  - c. Instructions for extended shutdown of pumping units between pump commissioning and full system operation. Include extended shut down maintenance and periodic operation schedule. Assume extended shutdown to last up to 5 years.

- C. RSN 33 12 71-2, Pumping Unit Calculations:
1. Calculations showing the expected forces pumping unit transfers to structure for specified conditions.
  2. Calculations and supporting documentation indicating pumping units will withstand specified seismic loadings as specified in this specification and bearing stamp of Professional Engineer registered in one of the 50 States of the United States or the District of Columbia ~~registered in the State of New Mexico~~.
  3. Certified statement that dynamic analyses have been completed in accordance with HI 9.6.8 and specified limitations will be met as defined in these specifications.
- D. RSN 33 12 71-3, Motor Approval Data and Drawings:
1. Catalog data, including manufacturer's name, type, model, size and dimensions for:
    - a. Induction motors.
    - b. Electrical terminal boxes.
    - c. Motor temperature relays.
    - d. RTDs.
    - e. Any provided accessories.
    - f. Motor bearing lubrication with Safety Data Sheet (SDS).
    - g. Expected RCF.
  2. Drawings and Data:
    - a. Assembly and sectional drawings with parts and list of materials, component weights, total weight, and location of center of gravity.
    - b. Motor outline drawings including thrust bearings and dimensioned location of terminal boxes.
    - c. Schematic, and wiring diagrams:
      - 1) Schematic Diagrams:
        - a) Armature winding connection.
        - b) Indicating and protective devices.
        - c) Space heaters.
      - 2) Wiring Diagrams:
        - a) Low-voltage terminal box.
    - d. Standard drawing 40-D-6032 completed for each size motor.
  3. Idle (motor stopped) time required for motor to cool from rated load temperature to ambient temperature. Running time (motor fully loaded) after two successive cold starts before a third start of motor may be initiated.
  4. Nameplate data.

5. Motor locked rotor current rating.
- E. RSN 33 12 71-4, Pumping Unit Certified Performance Test Data and Reports:
1. Pumping unit performance test data and curves for each pumping unit.
  2. Hydrostatic test report for each pump documented in accordance with HI 14.6.
  3. Certified Material Test Reports: Bowls, impellers, wearing rings, column pipe, discharge head, and shafts.
- F. RSN 33 12 71-5, Motor Factory Test Reports.
1. Factory test reports.
  2. Report containing the impact test results (as-built RCF) in both directions (to be denoted relative to conduit box location), as-built mass, and as-built center of gravity location.
- G. RSN 33 12 71-6, Pump Final Data and Drawings:
1. Electronic installation, operations, and maintenance manual with previously approved documents or with as-built revision noted:
    - a. Equipment function, normal operating characteristics, and limiting conditions.
    - b. As-built half-size (11- x 17-inch) drawings:
      - 1) Sectional assembly drawings with parts list and materials of construction.
      - 2) Pump unit outline drawings including motor with component weights.
      - 3) Pumping unit mounting detail drawings.
    - c. Certified pump performance test data with curves showing pump efficiency, horsepower, and total head with reference to capacity and operating speed. Include plot of NPSH required.
    - d. Certified hydrostatic test reports.
    - e. Certified Material Test Reports: Bowls, impellers, wearing rings, column pipe, discharge head, and shafts.
    - f. Field test report.
    - g. Installation, operation, and maintenance instructions as well as pump trouble shooting guide.
    - h. Pre-installation and pump storage and maintenance instructions.
    - i. Extended pump shutdown instructions and requirements for start-up after extended shutdown.
    - j. Mounting details including the pump manufacturer's recommended tightening torques.

- k. List of special tools and accessories required for assembly and disassembly of the pumping unit.
- l. Recommended spare parts list.
- m. Maintenance schedule in tabular form.
- n. Pumping unit structural calculations.
- o. Pump training manual.

H. RSN 33 12 71-7, Motor Final Data and Drawings:

- 1. Half-size (11- x 17-inch) drawings of:
  - a. Assembly and sectional drawings with parts and materials lists, and component weights.
  - b. Motor outline drawing including thrust bearings and dimensioned location of terminal boxes.
  - c. Motor nameplate drawings complete with nameplate data.
  - d. Standard drawing 40-D-6032 completed for each size motor.
  - e. “As-Built” schematic and wiring diagrams for motor approval drawings.
- 2. Installation, operation, and maintenance information including tools and accessories for assembly and disassembly of the motors:
  - a. Mounting details including the motor manufacturer’s recommended tightening torques for the motor mounting flange bolts.
  - b. Spare parts list.
  - c. Maintenance schedule.
  - d. Bill of materials.
- 3. Shop and field test reports.
- 4. Motor storage and maintenance instructions.
- 5. Motor RCF, mass, and center of gravity properties.

I. RSN 33 12 71-8, Field Test Plan:

- 1. Test plan including sequence of testing, pre-operational test equipment checkout form, field test form for recording data collected during pumping unit field test, and list of instruments and gauges which will be used to collect data.
- 2. List of acceptable measured value ranges for all data collected.
- 3. Target pump discharge pressure for each phase of testing and description of how pump discharge pressure will be adjusted using temporary test equipment without over pressurizing portion of system not designed to pump shutoff head.
- 4. Locations and means of diverting flow through temporary test piping.

5. Schedule for field testing with start times and durations or start and end times for each activity.
6. Detailed installation drawings of pumping unit field test temporary piping and equipment bearing stamp of Professional Engineer registered in one of the 50 States of the United States or the District of Columbia ~~Professional Engineer registered in the State of New Mexico.~~

J. RSN 33 12 71-9, Field Test Reports:

1. Contractor to provide report of tests which shall include:
  - a. Test equipment and instrumentation calibration records.
  - b. Drawing showing specific locations of vibration probes and bearing temperature sensors.
  - c. Pump manufacturer's representative signed report stating equipment has been properly installed, lubricated, in accurate alignment, free from undue stress imposed by connecting piping or anchor bolts, and has been operated under full load conditions satisfactory.
  - d. Presentation of vibration data in summary form and as comparison with specification requirements for allowable vibration limit established by HI 9.6.4.
  - e. Shaft alignment and runout measurements and comparison with allowable limits.
  - f. Data recorded during operating test in tabular form.
  - g. Observations and equipment adjustments performed during testing.
  - h. Detailed discussion and summary of conclusions drawn from vibration, motor bearing temperature, and motor voltage and amperage data that was recorded.

## 1.06 QUALIFICATIONS

1. Welding procedures, welding equipment, and welding operators qualified to either:
  - a. ASME BPVC-IX.
  - b. Standard Qualification Procedure of AWS D1.1.
2. Pumping Unit Manufacturer's Installation Representative(s) to have minimum 5-years of experience installing and commissioning vertical rotodynamic pumping units.

## 1.07 SERVICES OF MANUFACTURER'S INSTALLATION REPRESENTATIVE

- A. No work shall be performed on pumps or motors without applicable Manufacturer's Installation Representative being on-site to direct/oversee the work. Applicable

Manufacturer's Installation Representative(s) shall be on-site, at minimum, for the following operations:

1. Barrel installation, including setting and leveling.
2. Setting of pump and discharge head installation to barrel.
3. Alignment and coupling of pump to discharge pipe.
4. Alignment and coupling of motor to pump.
5. Motor field acceptance tests, including operational field motor test uncoupled from pump.
6. Functional testing.
7. Pumping unit field testing.
8. O&M training.

## **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Prevent damage to pumping unit components and associated equipment during loading, transportation, unloading, and storage.
- B. Repair damage to the pumping units and associated equipment as directed if, in the opinion of the COR, a satisfactory repair can be made; otherwise replace damaged pumping unit components and associated equipment.
- C. Protect from corrosion, deformation and other types of damage.
- D. Perform any required maintenance on pumping unit as directed by pump manufacturer prior to start-up.

## **PART 2 PRODUCTS**

### **2.01 VERTICAL PUMPING UNITS**

- A. Pump.
  1. Bowl Assembly:
    - a. Bowls made from cast iron, cast steel, or ductile iron: ASTM A48, ASTM A216, ASTM A536, or approved equal.
    - b. Design bowl assembly for easy removal of impeller and bearings.
    - c. Bowl castings interchangeable.
    - d. Provide suction case with bellmouth inlet.
    - e. Provide suction case with enough vanes to support lower guide bearing.
    - f. Provide means in bowl assembly to sustain weight of impeller and pump shaft when dismantling pump.

- g. Provide sand collar on bowl shaft above suction case bearing.
- h. Bowl wearing ring of stainless-steel material. Bowl wearing ring shall be renewable. Bowl and impeller wear ring faces shall have minimum Brinell hardness difference of 50BNH. Hard chrome or approved surface overlay of stainless-steel is acceptable to achieve hardness difference.
- i. Provide bowl shaft bearings above and below each impeller.
- j. Coat water passages with coating to minimize friction loss and as specified in Section 09 96 20 – Coatings.
- k. Inspect castings thoroughly. Ensure waterways and vanes are smooth and free from nodules, bumps, and dips. Casings shall be free of blow holes, sand holes, and other imperfections determined to decrease performance of pump outside of Table 33 12 71A – Performance Requirements or increase likeliness of cavitation or premature wear.
- l. Impeller:
  - 1) Impellers made of stainless-steel: ASTM A744, CF8M or CF3M; or approved equal.
  - 2) Impeller wearing rings of stainless-steel material.
  - 3) Securely fastened to shaft in such manner as to make it readily removable.
  - 4) Dynamically balance rotating parts to ISO 21940-11 balance quality grade G6.3 or better.
  - 5) Inspect castings thoroughly. Ensure waterways and vanes are smooth and free from nodules, bumps, and dips. Casings shall be free of blow holes, sand holes and other imperfections determined to decrease performance of pump outside of Table 33 11 30A – Performance Requirements or increase likeliness of cavitation.
- 2. Column Pipe Assembly:
  - a. Materials of Construction:
    - 1) Discharge column pipe: ASTM A106, ASTM A53, or approved equal.
    - 2) Flanges: ASTM A105, ASTM A181, ASTM A283, ASTM A36, or approved equal.
  - b. Bowl assembly to be supported from discharge head by a discharge column pipe.
  - c. Column pieces shall be interchangeable.
  - d. Provide discharge column pipe of steel construction not lighter than recommended by AWWA E103.
  - e. Size length of column pipe so bottom of suction bell inlet is one-half diameter of suction bell inlet above barrel bottom cap, or as recommended

by pump manufacture to avoid adverse hydraulic conditions in accordance with HI 9.8.

3. Discharge Head Assembly:
  - a. Materials of Construction:
    - 1) Pipe: ASTM A106, ASTM A53, or approved equal.
    - 2) Flanges: ASTM A105, ASTM A181, ASTM A283, ASTM A36, or approved equal.
    - 3) Plate: ASTM A36, ASTM A285, ASTM A516, ASTM A709, ASTM A572, or approved equal.
  - b. Provide a fabricated steel discharge head assembly with horizontal discharge.
  - c. Design for leak-free connection to barrel using an O-ring or gasketed connection for specified barrel pressures.
  - d. Design discharge head with enough stiffness to fully support pumping unit without deflection that exceeds one half clearance between shaft and bearing and allowable deflection of mechanical seal manufacturer. Meet allowable vibration requirements of HI 9.6.4 and separation margin dynamic analyses performed defined in HI 9.6.8.
  - e. Discharge head elbow wall-thickness equal to or greater than specified wall thickness of column pipe.
  - f. Design discharge head to carry weight of complete pumping unit and transmit to concrete structure entire horizontal thrust due to pressure at shutoff head and during startup and shutdown against closed valve.
  - g. Discharge head elbow interior diameter and flange shall be as shown on drawings for connection to the unit discharge piping.
  - h. Terminate the horizontal discharge with a flange size, class, bolt pattern, and location where shown on the drawings. Match pipe intersection elevation, modify height of pump pedestal.
  - i. Design discharge head to rigidly support pumping unit hung from steel base covering barrel opening.
  - j. Machine mating surfaces of motor flange and top of discharge head assembly, and bottom of discharge head assembly flat and parallel in order to obtain installation tolerances specified herein.
  - k. Provide jacking screws to facilitate alignment of the driver.
  - l. Provide a minimum 1/2-inch NPT (ANSI B1.20.1) threaded drain pipe connection and hose or tubing to drain seal leakage to floor drain. Route hose or tubing as directed by Government.
  - m. Dielectric coupling at discharge head to isolate dissimilar metallic materials.

- n. Provide a 2-inch NPT (ANSI B1.20.1) threaded pipe connection for combination air connection to allow admitting and venting of air from high point in barrel.
  - o. Provide lifting lugs with capacity to lift weight of pump.
  - p. Provide OSHA compliant coupling guard designed for easy installation and removal.
  - q. Pump nameplate securely mounted to discharge head containing the following information at minimum: Pump manufacturer name, rated flow, rated total head, rotational speed, bowl model number, number of stages, and pump manufacturer serial number.
4. Barrel:
- a. Materials of Construction:
    - 1) Barrel and suction pipe: ASTM A106, or approved equal.
    - 2) Discharge head mounting plate, end cap, and bottom mounting flange: ASTM A36, ASTM A285, ASTM A516, ASTM A709, ASTM A572, or approved equal.
  - b. Design in accordance with HI 9.8 except as modified herein.
  - c. Discharge head mounting surface perpendicular to barrel centerline within 0.016-inches.
  - d. Machine flat discharge head mounting surface to meeting installation tolerances as defined herein.
  - e. Terminate the horizontal suction pipe with an AWWA C207 Class D drilled and tapped flange located where shown on the drawings.
  - f. Provide a connection on suction pipe for pressure switch line located where shown on the drawings.
  - g. Barrel nominal diameter: 36-inch.
  - h. Suction pipe outside diameter: 30-inch.
  - i. Barrel length in accordance with controlling structural elevations shown on drawings.
  - j. Design for internal positive pressure of 25-psi and negative pressure of 12-psi:
    - 1) Minimum 5/16-inch barrel pipe wall thickness.
    - 2) Minimum 1/4-inch suction pipe wall thickness.
  - k. Provide flow-straightening vanes as recommended by HI 9.8.
  - l. Provide flange on bottom of barrel as shown on drawings to assist alignment and setting of barrel before encased in concrete. Circular bottom anchoring ring minimum thickness of 1-inch.

- m. Anchor top discharge head mounting plate to concrete. Size anchors to transfer all loads from the discharge head to concrete structure. Anchors may be cast-in-place headed studs or sleeved anchors.
5. Shafts:
- a. Materials of Construction:
    - 1) Provide ASTM A582, Type 416; ASTM A564 17-4 PH; or ASTM A276 UNS S32205 stainless-steel bowl shaft, top shaft and line shaft, or approved equal.
  - b. Size the line shaft to operate without distortion, stress, or vibration at maximum speed in both forward and reverse directions that exceeds pump design or industry acceptable limits.
  - c. Line shaft to be of enough size (diameter) to handle maximum thrust for all specified conditions.
6. Bearings:
- a. Provide suction case bearing below first-stage impeller.
  - b. Provide bearing immediately above impeller in each bowl.
  - c. Provide product-lubricated line-shaft bearings of sufficient number to maintain the alignment of shaft and prevent vibration in excess of limits specified in this specification.
7. Coupling:
- a. Provide coupling for connecting the line shaft to a solid shaft motor while assuring proper clearances and providing access for mechanical seal installation, removal, and maintenance.
  - b. Heavy-duty type sized for a minimum 1.5 service factor at motor horsepower and rotational speed nameplate rating.
8. Mechanical Seal:
- a. Cartridge type mechanical seal.
  - b. Design pumping unit to allow removal and install mechanical seal without removal of motor from discharge head.
    - 1) Split type mechanical seals not acceptable.
  - c. Use API Seal Plan 13 or Government approved seal plan recommended by pump and seal manufacture using product being pumped.
  - d. Designed for operating pressures and rotational speed of pump.
  - e. Designed for specified operating conditions at starting and shutdown of unit.
  - f. Designed for use with vertical pumping unit.
  - g. Seal face materials selected for specified product being pumped.

**B. Motor:**

1. Vertical, solid shaft, constant speed, NEMA Premium efficiency, induction, squirrel-cage designed for the duties specified.
2. Nameplate Ratings:
  - a. Voltage: 4,000, 3-phase, 60Hz.
  - b. Synchronous Speed: As required to meet pump performance requirements.
  - c. Duty: Continuous.
  - d. Locked-rotor KVA per Horsepower: Code letter G.
  - e. Service factor: 1.0.
3. Service Conditions:
  - a. Altitude: As indicated in Section 01 14 10 – Use of Site.
  - b. Maximum ambient temperature: 40 degrees C.
  - c. Designed for indoor service.
4. Enclosure type: Weather Protected I (WPI)
5. Horsepower Rating:
  - a. Enough to carry continuously maximum possible pump load developed under specified conditions without benefit of service factor.
  - b. Horsepower rating to be value listed in NEMA MG 1.
  - c. Maximum horsepower rating per motor permitted:
    - 1) Pumping Plant 4: 1,000 hp.
    - 2) Pumping Plant 7: 900 hp.
6. Temperature Rise: Not to exceed limits defined by NEMA MG1 for specified insulation class.
7. Starting Method: Reduced-voltage soft starting with an initially closed ball valve and check valve, and pump discharge line full of water.
8. Operate satisfactorily over expected range of total heads.
9. Starting Capability:
  - a. Capable of the following starting duty:
    - 1) Maximum number of starts per day: 12.
    - 2) Average number of starts per day: 8.
  - b. Motor to be capable of one hot start (motor initially at rated load temperature, or two successive cold starts (motor initially at ambient temperature) without exceeding a temperature rise that will cause injurious heating to any of the motor parts.

10. Nameplate Marking: As listed in NEMA MG 1 for alternating-current poly-phase squirrel-cage motors.
11. Conform to NEMA MG 1.
12. Suitable for installation in the space shown with enough access and working space to permit ready and safe operation and maintenance.
13. Coordinate motor characteristic requirements with torque requirements of pump so proper operation of unit will be obtained during sequence of starting, accelerating, and normal running over full operating range of pump.
14. Designed and constructed to rotate in reverse direction of rotation at maximum speed attainable.
15. Stator:
  - a. Stranded copper conductors.
  - b. Insulation Class F or H.
  - c. Coils completely sealed and moisture tight.
  - d. Winding configuration: Manufacturer's standard wye or delta.
  - e. Completed winding subjected to two vacuum pressure impregnations in solventless epoxy resin.
16. Rotor:
  - a. Design: Squirrel-cage winding of suitable impedance for starting under specified conditions. Rotor structure constructed in accordance with current practice.
17. Bearings:
  - a. Provide manufacturer's standard anti-friction type.
  - b. Thrust Bearing: Manufacturer's standard.
  - c. Upper and lower guide bearings: Manufacturer's standards.
  - d. Anti-friction type having a capacity meeting ABMA calculated rating life ( $L_{10}$ ) of no less than 50,000 hours at pump best efficiency point.
  - e. Lubrication: Grease or oil.
  - f. Self-cooled and sealed against loss of lubricant or entrance of dirt.
  - g. Provide means for removing the lubricant and re-lubricating the bearings without disturbing bearing housing.
18. Conduit Boxes:
  - a. Main Lead Terminal Box:
    - 1) Oversized.
    - 2) Attached to motor with at least four screws.
    - 3) Diagonally split, rotatable to each of four 90-degree positions.

- 4) Threaded hubs for conduit attachment.
  - 5) Provided with ground lug inside terminal box.
  - 6) Provide gaskets between box halves and between box and motor frame.
- b. Accessory Conduit Box:
- 1) Size: Suitable for terminating leads from indicating and protective devices, and motor accessories.
  - 2) Provide terminal blocks for terminating indicating and protective devices, and motor accessories.
  - 3) Manufacturer's standard cover with gasket.
19. Accessories:
- a. Space Heaters:
- 1) Provide space heaters to prevent condensation in the motor armature windings when the motor is shutdown for extended periods.
  - 2) Rating: 1-phase, 120-volt, 60Hz.
  - 3) Thermostatically controlled when motor is de-energized.
- b. Grounding Provisions: Provide pad with drilled and tapped bolt holes on motor enclosure. Pad to be machined flat and left unpainted.
- c. Lifting eyes attached to motor housing that are suitable for attaching slings for lifting with a crane. Lifting hooks or similar devices are not acceptable.
- d. Wire Markers:
- 1) Type: Machine-printable, self-laminating label or tubular heat-shrink sleeve label.
  - 2) Color: White.
- C. Motor Fabrication
1. Leads:
- a. Terminate all power and ancillary component leads in terminal box.
- b. Stator Armature Winding and Armature Leads:
- 1) Seal armature lead insulation to be equal to armature coil insulation about moisture resistance and voltage class.
  - 2) Armature leads brought out of stator frame to motor lead conduit box for external connections. Terminate armature leads with individual bolted-type solderless connectors.

2. Accessory Conduit Box:
    - a. Terminate indicating and protective devices, and motor and pump accessories at terminal blocks using ring-tongue connectors. Termination of bare conductors at terminal blocks is not acceptable.
  3. Wire Identification:
    - a. Provide computer-generated or labeling machine lettering.
    - b. Provide labels for wires associated with, heaters and indicating and protective devices.
- D. Indicating and Protective Devices:
1. General:
    - a. Determine scale range for the required operating conditions when scale range for instrument is not specified.
    - b. Pressure scales graduated in pounds per square-inch.
    - c. Temperature scales graduated in degrees F.
    - d. Provide nameplates for each instrument, electrical control device, and alarm switch supplied under this paragraph.
  2. Resistance Temperature Detectors (RTDs):
    - a. Provide each pump with RTDs for producing a signal for remote indication of the temperature of one RTD for each motor bearing and two RTD's per phase, located in stator slots between coil sides.
    - b. Three-wire RTD, 100-ohm platinum type.
  3. Nameplates:
    - a. Provide in accordance with standard drawing 40-D-6234.
    - b. Include in the nameplate captions, the device function number (where applicable) and the nameplate device description:
      - 1) Nameplate captions can be changed by COR at the time the nameplate list drawing is first submitted for approval at no change in contract price or delivery.
      - 2) Device function numbers to be assigned at the time the drawings are first submitted for approval.

## **2.02 DYNAMIC ANALYSES**

- A. Lateral Analysis:
1. Determine potential for critical lateral frequency occurring within design range of pumps specified. Lateral dynamic analysis performed in accordance with HI 9.6.8. Acceptance criteria for minimum frequency separation margin in accordance with HI 9.6.8 based on level of analysis performed.

- B. Torsional Analysis:
  - 1. Determine potential for critical torsional frequency occurring within design range of pumps specified. Torsional analysis performed in accordance with HI 9.6.8. Acceptance criteria for the minimum frequency separation margin in accordance with HI 9.6.8 based on level of analysis performed.
- C. Structural Analysis, Vertical Pump Structures:
  - 1. Determine potential for critical structural natural frequency occurring within design range of pumps specified. Structural analysis performed in accordance with HI 9.6.8. Acceptance criteria for minimum frequency separation margin in accordance with HI 9.6.8 based on level of analysis performed.

### **2.03 PUMP SHOP ASSEMBLY AND TEST REQUIREMENTS**

- A. Completely assemble mating parts of pumping unit in shop to ensure correct fitting of all parts. Match-mark pump components before disassembly for shipment, unless shipped completely assembled, to ensure correct field assembly.
- B. Test each pumping unit at manufacturer's shop or at another test facility agreed upon by CO to establish that specifications performance requirements and warranties under this contract have been fulfilled.
- C. Performance test made with job pump and job motor assembled as complete operating unit.
- D. Provide COR minimum of 4-weeks' notice before witnessed test date at locations in the United States of America and 8-weeks' notice before witnessed testing date at locations outside of the United States of America. At minimum, include in notification letter testing that will be performed, date and time of testing, and physical address of testing facility.
- E. Hydrostatic pressure testing:
  - 1. Government may witness hydrostatic test of each pumping unit.
  - 2. Hydrostatically test pump bowls, column pipe, and discharge head in accordance with HI 14.6 except as modified herein:
    - a. Minimum test pressure of parts 1.5 times bowl shutoff pressure.
    - b. Test fluid to be clear clean water.
- F. Pump performance testing:
  - 1. Government will witness performance test of each pumping unit.
  - 2. Unless otherwise specified, use test procedures and instruments conforming to HI 14.6 for a grade 1 test.
  - 3. Instrument calibration intervals less than recommended by HI 14.6 Appendix J.

4. Acceptance of test results based on pump performance.
5. Acceptance of test results based on water at 70 degrees F.
6. Best fit curve for acceptance of test results must pass through test data points.
7. Perform performance testing with all internal pump final coatings applied.
8. Conduct performance test with complete pumping unit.
  - a. Reduced stage testing not permitted:
9. Conduct performance tests at rated speed:
  - a. When determining pump horsepower from power input to motor perform test at job voltage plus or minus 5 percent and at rated frequency plus or minus 1 percent.
  - b. When determining pump horsepower from dynamometer, or torque meter and speed perform test at full speed rating with an allowable tolerance on rotational speed of plus or minus 1 percent.
10. Use HI 14.6 acceptance grade 1U for rate of flow and total head.
11. Guarantee point is the rated total head and capacity shown in Table 33 12 71A – Performance Requirements.
12. Minimum pump efficiency at guarantee point shown in Table 33 12 71A – Performance Requirements.
13. Take readings at minimum of eight points while operating at pump rated speed including:
  - a. One point between 0 and plus 5 percent of the guarantee point flow rate.
  - b. One point between 0 and minus 5 percent of the guarantee point flow rate.
  - c. One point at shutoff head.
  - d. One point at the expected minimum head operating point flow rate.
  - e. One point at expected maximum head operating point flow rate.
  - f. One point at expected flow rate where intersection of rated system curve and two pumps operating in parallel occurs.
  - g. One point at expected flow rate where intersection of rated system curve and three pumps operating in parallel occurs.
  - h. One point at flow rate 10 percent greater than expected minimum head operating point flow rate.
14. Changes in impeller diameter or other rework to pumping units requires retesting of pumping unit performance.
15. Prepare and submit test reports:
  - a. Performance curves at rated speed showing pump efficiency, horsepower input to the pump, and pump discharge heads from the minimum head specified in Table 33 12 71A – Performance Requirements to pump shutoff head.

- b. Present test data at both test speed and corrected to rated speed for acceptance. Portion of curve above maximum head operating point to shutoff head may be plotted from previous shop test data.
- c. Test conditions: Test liquid temperature, instrument calibration records with serial numbers and photos of matching instruments used, NPSHA, motor data, and test standard and acceptance grade.

## **2.04 MOTOR SHOP TEST**

- A. Assemble and test motor at the manufacturer's shop to establish that performance requirements of these specifications and warranties under this contract have been fulfilled.
- B. Perform manufacturer's routine factory tests and following the routine tests required by Part 20 of NEMA MG 1:
  - 1. Measurement of winding resistance.
  - 2. No-load motoring readings of current, power, and nominal speed at rated voltage and frequency.
  - 3. Alternating-current (AC) high-potential test. A direct-current (DC) high-potential test is not acceptable.
  - 4. Perform temperature test (by resistance) on one motor of each horsepower size.
- C. Perform tests in accordance with requirements of NEMA MG 1 and IEEE 112.
- D. Perform Motor RCF impact test in accordance with HI 9.6.8 Appendix D.4.
- E. Report Motor RCF impact test results in accordance with HI 9.6.8 Appendix F:
  - 1. After manufacture of motor and prior to shipment, motor RCF, mass, and center of gravity properties shall be verified at motor manufacturer's facility. In the case of RCF, this involves an impact test in two perpendicular planes, to be denoted relative to conduit box location.
  - 2. If as-built values of RCF, mass, and center of gravity location are outside allowed tolerances, motor manufacturer shall inform Government, correct, and verify correction at no additional cost to the Government prior to shipment of motor.

## **2.05 ACCESSORIES**

- A. Lubricating oil and grease:
  - 1. In accordance with pump and motor manufacturer's recommendations:
    - a. Lubricating grease and oil which may come in contact with water shall be NSF 61 compliant.

- B. Anchors:
  - 1. Barrel leveling using post installed epoxy anchoring system or cast in place headed anchors.
- C. Air Valve Assembly:
  - 1. As shown on drawings and in accordance with Sections 35 21 95 – Steel Manifold Piping and 35 22 14 – Valves and Equipment.
- D. Grout:
  - 1. Cementitious grout below the barrel mounting flange in accordance with Section 03 62 20 – Nonshrink Grout for Equipment and Metalwork.

## **2.06 TEMPORARY PUMPING UNIT FIELD TEST EQUIPMENT**

- 1. Contractor to supply all necessary equipment for field test of pumping units using a temporary bypass piping from discharge side of pumping plant to tank upstream of pumping plant.
- 2. Piping and equipment downstream of each pumping units discharge piping 16-inch ball valve is not designed for shutoff head pressures. Do not subject this piping to pressures above pressures associated with maximum head operating point.

## **2.07 SHOP AND FIELD COATINGS**

- A. Coat in accordance with Section 09 96 20 – Coatings.
- B. Passivate stainless-steel surfaces in accordance with Section 09 96 20 – Coatings.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install pumping unit in accordance with pump manufacture's and motor manufacture's recommendations except as modified here in.
- B. Install anchoring system complete as shown on drawing and other devices necessary to install pumping unit.
- C. Service pumping unit to including complete lubrication, adjusting, and cleaning of the unit.
- D. Correctly assemble and align all parts of the pumping unit.
- E. Apply NSF 61 Compliant anti-seize compound to shaft before shaft is assembled.

- F. After being serviced, pumping unit shall be installed by a qualified person under the supervision of the Manufacturer's Installation Representative(s) from the pumping unit or pump and motor manufacturers and manufacturer's installation instructions.
- G. Tighten barrel anchors (as applicable), discharge head mounting bolts, motor flange bolts, and pump shaft coupling bolts to pumping unit manufacturer's recommended torque, as submitted in manufacturer's data, using calibrated tools before operating tests.
- H. Barrel:
1. Install as shown on drawings and accurately locate suction pipe and barrel discharge head mounting surface for alignment with mating components.
  2. Anchor and brace as required to maintain barrel plumb within 1/8-inch per 8-feet and discharge head mounting surface on barrel level to within 0.002-inch per foot.
  3. Protect barrel from damage from weather and nearby construction activities. Maintain condition of discharge head mounting surface per pump manufacturer's written instructions for duration of time before pump is installed.
  4. Thoroughly clean discharge head base and barrel discharge head mounting surface before installation of discharge head to remove all dirt, rust, coatings, and other foreign matter.
  5. Thoroughly clean all dirt and burrs from couplings, flange faces, and machined surfaces before connection to ensure tight fit and true alignment.
  6. Before installing pump ensure all construction waste and accumulated debris have been removed from the barrel and suction piping.
  7. Grout and concrete placed around barrel to be free of voids.
  8. Connect pump to discharge head. Mount discharge head (without motor) to the barrel and connect to discharge piping:
    - a. Clearance between discharge head and barrel discharge head mounting surface not to exceed 0.004-inch prior to installing gasket and bolting down the discharge head. Discharge head to barrel discharge head mounting surface connection shall be leak free. Re-machine discharge head or barrel discharge head mounting surface if not within tolerance.
    - b. Check level and flatness of top machined surface of discharge head at four locations spaced 90 degrees apart using machinist's level calibrated at 0.0005-inch per division. Verify top machined surface of discharge head is level within 0.002-inch per foot maximum deviation from horizontal.
    - c. Shims not allowed.
- I. Mount vertical motor on top of machined surface of discharge head:
1. Clearance between mating surfaces not to exceed 0.004-inch prior to bolting down the motor:
    - a. Re-machine discharge head or motor if not within tolerance.

2. Any excess oil installed in the motors, while they were stored, shall be drained.
  3. Verify alignment of motor shaft with pump top shaft is within manufacturer's allowable tolerance. Maximum shaft runout 0.0015-inch per inch of shaft diameter.
  4. Connect pump top shaft to motor shaft. Vertical adjustment of the pump impeller shall be made in accordance with manufacturer's instructions.
- J. Provide and connect ground connection from the motor and pumping unit to the facility grounding system.
- K. Terminate armature leads and external motor cables. Make terminations in accordance with manufacturer's instructions and recommendations.
- L. Before connecting pump to discharge piping, ensure all construction waste and accumulated debris have been removed.
- M. Connection of pump to discharge piping will be witnessed by Government and pump manufacturer's representative.
- N. After piping has been connected, re-verify alignment of motor shaft with pump top shaft is within manufacturer's allowable tolerance. Maximum shaft runout 0.0015-inch per inch of shaft diameter.

### **3.02 SERVICING AND FIELD TESTING**

- A. Lubricate, adjust, and clean pumping unit after installing in accordance with pump manufacture's recommendation.
- B. Calibrate all permanent gauges, instruments, and recording and sensing devices and adjust equipment to ensure proper pumping system operation. Instruments shall be factory set and calibrated to greatest extent possible. Record all set points and ranges in field test report.
- C. Before initially energizing pump motor, successfully test all motor control, monitoring, and protective circuits. Successfully test all motor control, monitoring, and protective circuits in accordance with Section 26 05 90 – Wiring Checkout and Tests.
- D. After servicing, perform 4-hour field motor test with the motor uncoupled from the pump:
1. Record motor bearing temperatures, voltage, and amperage every 15-minutes.
  2. Test conducted by Contractor and witnessed by Government for each motor.
  3. Provide minimum of 14-days' notice to Government prior to motor testing.
- E. After servicing and field motor test, perform an operating test on each pumping unit under load:
1. Contractor to supply all testing equipment.

2. Contractor to fill tank and system and temporary pump field test piping with potable water:
  - a. Fill and maintain tank to at least minimum water elevation.
  - b. Maintain water temperature below 80 degrees F and as recommended by pump manufacturer during pumping unit testing.
  - c. Ensure all debris is removed from tanks and piping system prior to filling with water.
3. Contractor to simulate pump total head for operating points specified by modifying pressure loss in temporary test piping.
4. Take readings with gauges and meters with current calibration records as recommended by HI 14.6.
5. Test conducted by Contractor and witnessed by Government for each pump. Individual tests shall be performed for each pump. Do not test more than one pump at any time.
6. Provide a minimum of 14-days' notice to Government prior to pump testing.
7. Record shaft alignment and runout measurements at the motor to pump shaft coupling before and after the operating test for each unit and compare to allowable tolerances.
8. During the test, for each observation point, observe and record pumping unit operation, water temperature, tank level, suction pipe pressure, flow rate from flowmeter, discharge pressure, motor speed, noise level in accordance with HI 9.2, vibration analysis, and motor bearing temperatures, voltage, and amperage:
  - a. Operate each pump for minimum of 1-hour at minimum head operating point. Take readings at start and end of hour.
  - b. After successful testing of pump at minimum head operating point, operate each pump at rated head. Take readings for 8-hours: Once every 30-minutes for first two hours; once every hour for the next 5-hours; and once every 30-minutes for last hour.
  - c. Record readings in tabular form.
  - d. Provide full spectrum vibration analysis using a monitor that records and prints analysis results prior to testing vibration levels. Vibration levels not to exceed acceptable field vibration limits established by HI 9.6.4.
    - 1) If, after installation, pumping unit does not meet these requirements, modify pump and motor at no additional cost to Government to meet these requirements. Use of frequency adjusting devices (such as washers and dampers) between discharge head assembly and motor is not permitted.
9. Inspect discharge head base and discharge pipe connection for leakage. If leaks are present repair and retest at no additional cost to Government.

10. Inspect mechanical seal for leakage and record leakage rate if leakage is present. If leakage from mechanical seal is greater than 2 drops per hour repair and retest at no additional cost to Government.
11. Check all bolt torque values at conclusion of the tests using calibrated tools.
12. At completion of pumping unit field testing and coordinated with COR:
  - a. Remove and dispose of water.
  - b. Remove and dispose of temporary test piping system.
  - c. Install blind flanges and gaskets where temporary test piping connected to permanently installed pipe in accordance with these specifications.

### **3.03 TRAINING**

- A. Pumping unit operations and maintenance training to include, but is not limited to, the following:
  1. Content of the training shall include:
    - a. Pump system overview.
    - b. Pump performance.
    - c. System operations and interface with the SCADA system.
    - d. Pump installation and removal instruction.
    - e. Maintenance schedule and routine maintenance requirements.
    - f. Use of special tools.
    - g. Trouble shooting, alarms, and common mistakes.
    - h. Manufacturer's recommended training for the operation, maintenance, and repair of pumping units.
  2. Training should include in class and hands on portion. Training must include system walk through at the pumping station.
  3. Provide printed training material for each attendee.
  4. Duration: 8-hours.
  5. Number of attendees: Up to 30.

**END OF SECTION**

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**SECTION 33 16 14**  
**AIR CHAMBERS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Air Chambers and Air Compressors:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 REFERENCE STANDARDS**

A. American Institute of Steel Construction (AISC)

1. AISC 360-16 Specification for Structural Steel Buildings

B. American National Standards Institute (ANSI)

1. ANSI A14.3-2008 Ladders – Fixed – Safety Requirements
2. ANSI A1264.1-2017 Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail Systems
3. ANSI/NSF 61-17 Drinking Water System Components – Health Effects
4. ANSI/NSF 372-16 Drinking Water System Components – Lead Content

C. American Society of Mechanical Engineers (ASME)

1. ASME B1.20.1-2013 Pipe Threads, General Purpose (Inch)
2. ASME B16.3-2016 Malleable Iron Threaded Fittings: Classes 150 and 300
3. ASME B16.39-2014 Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300
4. ASME B16.9-2012 Factory-made Wrought Buttwelding Fittings
5. ASME B16.11-2016 Forged Fittings, Socket-Welding and Threaded
6. ASME 31.1-2018 Power Piping
7. ASME B40.100-2013 Pressure Gauges and Gauge Attachments

- |  |                            |   |
|--|----------------------------|---|
| 8.   | ASME BPVC-VIII-1-2017      | ASME Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels  |
| 9.   | ASME BPVC-IX-2017          | ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications  |
| D. ASTM International (ASTM)               |                            |   |
| 1.   | ASTM A36/A36M - 14         | Carbon Structural Steel   |
| 2.   | ASTM A53/A53M - 12         | Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless   |
| 3.   | ASTM A105/A105M - 14       | Carbon Steel Forgings for Piping Applications   |
| 4.   | ASTM A139/A139M - 16       | Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)  |
| 5.   | ASTM A516/A516M - 17       | Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service   |
| 6.   | ASTM A1011/A1011M-17a      | Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength   |
| 7.   | ASTM A1018/A1018M-18       | Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| E. American Water Works Association (AWWA) |                            |   |
| 1.   | AWWA C512-15               | Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service  |
| F. Code of Federal Regulations (CFR)       |                            |   |
| 1.   | 29 CFR Part 1910 Subpart D | Occupational Safety and Health Administration (OSHA) Standards – Walking-Working Surfaces   |
| G. International Code Council              |                            |   |
| 1.   | IBC-2015                   | International Building Code   |

- H. International of Electrical and Electronics Engineers (IEEE)
1. IEEE 43-2013 Recommended Practice for Testing Insulation Resistance of Electric Machinery
- I. International Organization for Standardization (ISO)
1. ISO 8573-1:2010 Compressed air – Part 1: Contaminants and purity classes
- J. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
1. MSS SP-80-2013 Bronze Gate, Globe, Angle and Check Valves
  2. MSS SP-110-2010 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- K. National Electrical Manufacturers Association (NEMA)
1. NEMA ICS 2-2000 (R2005) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts
  2. NEMA ICS 5-2017 Industrial Control and Systems Control Circuit and Pilot Devices
  3. NEMA MG 1-2016 Motors and Generators
  4. NEMA 250-2014 Enclosures for Electrical Equipment (1,000 Volts Maximum)

## 1.02 SUBMITTALS

- A. Submit the following in accordance with the requirements of Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 33 16 14-1, Qualifications.
1. Welder/welding operator performance qualifications and welding procedure specifications forms QW-484A, QW-484B, QW-482 and QW-483.
- C. RSN 33 16 14-2, Air Chambers Data and Drawings:
1. Checked, detailed shop drawings which include dimensions and tolerances, steel plate thicknesses, material data, joint details, ladder, and welding requirements.
  2. Design calculations, design considerations, and referenced publications and standards used in the design of the air chamber, supporting skirt, anchor bolts, and base plate.

3. Design data which shows magnitude and direction of reactions at base of each air chamber anchor bolt (or designing controlling bolt). Provide anchor bolt location, diameter, and material strength. Do not proceed with foundation reinforcement until receipt of revised drawings.
  4. Commercial products data for equipment associated with the air chamber.
- D. RSN 33 16 14-3, Air Compressors and Compressed Air Filtration System Data and Drawings:
1. Commercial products data.
  2. Shop drawings or commercial products data which details sound attenuating enclosure.
  3. Compressor sizing data and calculations showing air compressor unit will deliver minimum specified rate of air flow.
  4. Performance data: Rate of flow (inlet cubic feet of free air per minute) of air compressor unit at normal operating pressures of 228 pounds per square inch gauge (psig) for Pumping Plant No. 4 and 251 pounds per square inch for Pumping Plant No. 7.
  5. Assembly drawings.
- E. RSN 33 16 14-4, Air Compressor Piping Calculations and Drawings:
1. Submit checked shop and installation drawings for air compressor piping and air compressor piping supports.
  2. Submit calculations detailing structural design of air compressor piping supports. Calculations must be stamped and signed by a professional engineer registered in the State of New Mexico.
- F. RSN 33 16 14-5, Commercial Products Data:
1. Level indicating and switch module assembly.
  2. Differential pressure transmitter.
  3. Air release valves:
    - a. Calculations that valve will release a minimum air rate of 10 percent greater than air delivered by air compressor at pressures of 228 psi for Pumping Plant No. 4 and 251 psi for Pumping Plant No. 7.
  4. Ball valves.
  5. Globe valves.
  6. Pressure safety relief valves.
  7. Automatic drain valve.
  8. Pressure gauges.

9. Check valves.
  10. Safety rail for the ladder.
  11. Compressed air filtration system components:
    - a. Liquid separator and filter.
    - b. Oil coalescing coarse filter.
    - c. Oil coalescing fine filter.
    - d. Oil vapor filter.
  12. Oil water separator for air filtration drainage.
- G. RSN 33 16 14-6, Service Manuals:
1. Air compressors.
  2. Level indicating and switch module assembly.
  3. Differential pressure transmitter.
  4. Air release valves.
  5. Ball valves.
  6. Globe Valves.
  7. Pressure safety relief valves.
  8. Automatic drain valve.
  9. Pressure gauges.
  10. Check valves.
  11. Compressed air filtration system components:
    - a. Liquid separator and filter.
    - b. Oil coalescing coarse filter.
    - c. Oil coalescing fine filter.
    - d. Oil vapor filter.
  12. Oil water separator for air filtration drainage.
  13. Air chamber hydrostatic test results.
- H. RSN 33 16 14-7, Control Cabinet Equipment Layouts, Electrical Bill of Material, Nameplate Lists, Schematic and Wiring Diagrams Approval Drawings:
1. Provide schematic diagram drawings for air chamber surge controller showing entire control circuit.
  2. Provide separate schematic diagram drawings for air compressors showing entire control circuit, including interconnection to air chamber pressure controller.

- I. RSN 33 16 14-8, Check Prints:
  - 1. In accordance with section 01 33 26 – Electrical Drawings and Data.
- J. RSN 33 16 14-9, Final Drawings:
  - 1. Complete set of As-Built drawings:
    - a. Clearly mark drawings 1695-D-60610 through 1695-D-60614 to show all field modifications of the final installation.
    - b. Submit drawings in accordance with Section 01 33 00 – Submittals article 1.04 paragraph C.6 and Section 01 78 30 – Project Record Documents.

### **1.03 PERFORMANCE REQUIREMENTS**

- A. Design, furnish, and install 4 air chambers, 2 air compressors, 2 air filtration systems and associated equipment for each pumping plant. One air compressor will supply air to 4 air chambers when required. Provide alternator controller to equalize runtime between two air compressors. There are two Pumping Plants, No. 4 and No. 7.
- B. Design for operation at provided project conditions per 01 14 10 – Use of Site.
- C. General:
  - 1. Design to comply with NSF 61 and NSF 372 requirements.
  - 2. Designed to comply with OSHA requirements.
  - 3. Suitable for potable water.
  - 4. Dielectrically isolate dissimilar metals. Provide dielectric insulating unions as necessary to prevent galvanic corrosion between dissimilar metals.
  - 5. All calculations must be stamped and signed by a professional engineer registered in the State of New Mexico.
- D. Function of the Air Chambers:
  - 1. Air chambers:
    - a. Provide surge protection to prevent formation of water column separation due to downsurge.
    - b. Maintain maximum pressure, due to the upsurge, below the design pressure limits of the pipe, fittings and valves.
  - 2. Expected maximum internal pressure rise during the maximum upsurge, the water hammer pressure, measured at the invert of the air chamber:
    - a. Pumping Plant No. 4: 264 psig (610 feet of water head).
    - b. Pumping Plant No. 7: 294 psig (680 feet of water head).

3. During normal operations, the maximum internal pressures measured at the invert of the air chamber are:
    - a. Pumping Plant No. 4: 228 psig (525 feet of water head).
    - b. Pumping Plant No. 7: 251 psig (579 feet of water head).
- E. Design Codes:
1. Design the air chambers in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.
  2. Wind and earthquake loads: See drawing 1695-D-60399.
- F. Loading Conditions:
1. Wind loading during construction shall be considered if the air chamber is erected before the building is enclosed.
  2. Water hammer pressure with the water level at EMERGENCY PUMPS OFF plus construction wind loading.
  3. Normal operating pressure with the water level at EMERGENCY PUMPS OFF plus construction wind loading.
  4. Normal operating pressure with the water level at EMERGENCY PUMPS OFF plus seismic loading.
  5. Hydrostatic test condition plus construction wind loading.
  6. Empty air chamber with construction wind loading.
  7. Empty air chamber with seismic loading.
- G. Determine steel plate thickness of the air chamber, supporting skirt, and base plate considering above conditions. A minimum thickness for the supporting skirt and base plate is shown on the drawings. Increase thicknesses if calculations show that a thicker material is needed.
- H. Determine size and number of anchor bolts needed to fasten the air chamber and skirt to concrete foundation. Provide anchor bolt chairs similar to those shown on the drawings:
1. Anchor bolt requirements:
    - a. Minimum anchor bolt diameter: 1.25-inch. A larger diameter bolt may be necessary.
    - b. Anchor bolts to be evenly spaced on the bolt circle diameter.
- L. Level indicating and switch module assembly:
1. The switch modules and associated equipment provide level alarms to SCADA.
    - a. Air chamber level high water level alarm set at EMERGENCY PUMPS OFF level.

- b. Air chamber level low water level alarm set at AIR RELEASE level.

I. Differential pressure transmitter:

1. The differential pressure transmitter and air chamber surge control panel control the automatic operation of the air compressor, air chamber emergency alarms, and pump shutdown:
  - a. EMERGENCY PUMPS OFF (Main pumps are locked out and SCADA indicates an alarm condition when the water in the air chamber reaches this level in the tank).
  - b. COMPRESSOR ON (Air compressor to start when the water in the air chamber reaches this level).
  - c. COMPRESSOR OFF (Air compressor to stop when the water in the air chamber reaches this level).
  - d. AIR RELEASE (SCADA indicates an alarm condition when the water in the air chamber reaches this level).

M. Alternating lead compressor operation. Alternating feature shall alternate air compressor upon each start up.

J. Air Release Valve:

1. Purpose: Release air from air compressor to maintain a minimum water level in the air chamber in the event of an air compressor malfunction.

K. Pressure vessel ladders:

2. Designed to meet the load requirements as prescribed by 29 CFR Part 1910 Subpart D, ANSI A14.3, and ANSI A1264.1.
3. Designed for dead, live, and any combination of loads thereof, in accordance with the IBC.
4. Designed and fabricated in accordance with the applicable requirements in AISC 360.
5. Materials and welding shall conform to all applicable requirements of ASIC 360.
6. Provide exterior ladder from the floor to the top of the pressure vessel

## 1.04 QUALIFICATIONS

- A. Welders and welding procedures: Qualified in accordance with Section IX of the ANSI/ASME Boiler and Pressure Vessel Code, Article II - Specification for Welding Procedure and Article III – Welding Performance Qualification.
- B. Government may witness the welding of qualification test plates and physical testing of specimens taken from these plates. Contractor shall notify Government 30-days prior to qualification test plate welding.

- C. Certification of tests and results from a testing laboratory approved by Government may be accepted in lieu of witnessing tests.

### **1.03 DELIVERY, STORAGE, AND HANDLING**

- A. Prevent damage to equipment during loading, transportation and unloading. Repair and replace damaged equipment as directed by Contracting Officer Representative (COR):
1. Assemble and match mark to ensure correct fitting of parts in the manufacturer's shop.
  2. Disassemble only as necessary for shipment.
  3. Cover pipe connections with wood flange covers, pipe plugs, or other suitable means for protection and to prevent entrance of foreign matter during delivery, storage and handling.
  4. Furnish one set of special wrenches and special tools required to assemble and disassemble the air compressor and motor.

## **PART 2 PRODUCTS**

### **2.01 EQUIPMENT AND MATERIALS**

- A. General:
1. Design to comply with NSF 61 and NSF 372 requirements.
  2. Suitable for potable water.
  3. Dielectrically isolate dissimilar metals. Provide dielectric insulating unions as necessary to prevent galvanic corrosion between dissimilar metals.
- B. Steel Plate:
1. ASTM A36, ASTM A1011, SS, Grade 36, 40, or 45; or ASTM A1018, SS, Grade 36 or 40 for tank skirts and other structural elements.
  2. ASTM A516, Grade 70 with 4.1 additional tension test for pressure vessels.
- C. Standard and Schedule Steel Pipe:
1. ASTM A53, type E or S, Grade B:
    - a. Pipe 4-inches in diameter and smaller: Galvanized.
    - b. Pipe larger than 4-inches in diameter: Coated in accordance with Section 09 96 20 – Coatings.
- D. Electric-Fusion (Arc)-Welded, Spiral Seam Steel Pipe: ASTM A139, Grade B or C.

- E. Malleable Iron Threaded Fittings:
1. ASME B16.3.
  2. Class 300.
- F. Malleable Iron Threaded Unions:
1. ASME B16.39.
  2. Class 300.
- G. Threaded steel fittings:
1. ASME B16.11 and ASTM A105.
  2. Class 300.
  3. Threaded NPT: ASME B1.20.1.
- H. Welding Fittings:
1. ASME B16.9.
- I. Flanges, Gaskets, Bolts, and Nuts:
1. See Section 35 21 95 – Steel Manifold Piping and drawings.
- J. Manholes:
1. Designed by air chamber manufacturer.
  2. Diameters of openings as shown on the drawings.
  3. Provide a hinged davit manhole door.
  4. Provide a handle on the door.
- K. Flat Washers: SAE type. Provide flat washers under bolt heads and nuts.
- L. Support Channels and Pipe Clamps:
1. P-1000 and P-1113 respectively, as manufactured by Unistrut Service, [www.unistrutuohio.com](http://www.unistrutuohio.com); or equal, having the following essential characteristics:
    - a. Minimum thickness: 12 gauge (0.1046 inch).
    - b. Galvanized-strip steel.
- M. Level Indicating and Switch Module Assembly:
1. SureSite - Standard Alloy Visual Level Gauge model, as manufactured by Gems Sensors and Controls, [www.gemssensors.com](http://www.gemssensors.com); or equal, having the following essential characteristics:
    - a. Standard size, 2 1/2-inch diameter, 316 stainless steel housing and float material suitable for an operating pressure equal to 300 psig.

- b. Provide length of level indicator as shown on drawings.
- c. T8 top connection (top removal male connection) and B8 bottom connection (bottom removal male connection), as shown on the drawings.
- d. Manual isolation ball valves on the air and water side connections.
- e. Switch Modules: Rated NEMA ICS 5: A600. Provide switch modules at the following levels:
  - 1) Air chamber level high water level alarm.
  - 2) Air chamber level low water level alarm.

N. Differential pressure transmitter:

- 1. Rosemount Model 3051L differential pressure transmitter by Emerson Process Management, [www.emerson.com](http://www.emerson.com), or equal, having the following essential characteristics:
  - a. Incorporated within the control system for each air chamber.
  - b. HART communication protocol.
  - c. Continuous monitoring.
  - d. Temperature range: 0 to 150 degrees F.
  - e. Provide braided hose, gaskets and fasteners for connection to the braided hose connection assembly at the top of the air chamber.
  - f. Suitable for connection to 2-inch side mounted flange.
  - g. Differential pressure measurement range: 0 to 25 psig.
  - h. Suitable for pressures up to 300 psig.
  - i. Isolating diaphragm: 316L stainless steel.
  - j. Transmitter sensor fill: Silicone oil.
  - k. Low pressure braided hose fill: Air.
  - l. Liquid Crystal Display with local operator interface.
  - m. Output signal: 4-20 milliamperes DC corresponding to 0-100 percent of air chamber water level.
  - n. Transmitter: Suitable for operation on 10 to 36 volt DC external power supply.
  - o. Adjustable offset (zero) and span.
  - p. Accuracy: Plus or minus 0.25 percent.
  - q. Vent/Drain valve.
  - r. Process connection: 1/2-inch 14 NPT female.

- s. Enclosure: In accordance with NEMA 250; insulated NEMA Type 4X, IP 67 or IP 68.
- t. Furnish and install a complete ready for operation system capable of quickly and accurately measuring the differential pressure levels shown on the drawings.
- u. Transient Protector:
  - 1) Protects pressure transmitter from damage due to lightning and switching surges.
  - 2) Compatible with pressure transmitter output of 4 to 20 milliamperes.
  - 3) Same manufacturer as pressure transmitter.

O. Ladder Fall Protection:

- 1. Safety rail: Miller Saf-T-Climb as manufactured by Honeywell Miller, [www.millerfallprotection.com](http://www.millerfallprotection.com); or equal, having the following essential characteristics:
  - a. Round cross section.
  - b. Allow sleeve to swing completely around when climber reaches the top, to allow the climber to step away from the ladder without disconnecting the sleeve.
  - c. Flat safety rail: Not acceptable.
  - d. Provide one sleeve and belt with tank.

P. Ball Valves:

- 1. MSS SP-110, stainless steel, full-ported, female screwed ends.
- 2. Cold-water pressure rating, minimum: 400 psig.
- 3. Bubble tight at rated pressure in either direction.
- 4. Suitable for operation after long periods of inactivity.

Q. Pressure Safety Relief Valves:

- 1. 900 series as manufactured by Emerson, [www.emerson.com](http://www.emerson.com); or equal, having the following essential characteristics:
  - a. Designed in accordance with requirements of ASME BPVC, Section VIII, Division 1.
  - b. Suitable for air service.
  - c. Bronze or iron body, stainless steel trim.
  - d. Threaded inlet and outlet.

- e. Relief valve pressure settings for the air chamber valves shall be equal to the maximum allowable working pressure plus 10 percent according to UG-98 of ASME BPVC, Section VIII, Division 1.

R. Air Release Valves:

1. Air release type manufactured by Val-Matic Valve and Manufacturing Corporation, [www.valmatic.com](http://www.valmatic.com), DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com), Crispin Valves, [www.cripinvalve.com](http://www.cripinvalve.com); or equal, having following essential characteristics:
  - a. AWWA C512.
  - b. Air release type.
  - c. Sized to allow air to be continuously and automatically released from the air chamber if the water level in the air chambers reaches the AIR RELEASE level during normal operation conditions.
  - d. Capacity, minimum: 10 percent greater than the standard free air rate discharge of the air compressor operating at 228 psig at Pumping Plant No. 4 and 251 psi at Pumping Plant No. 7.
  - e. Valve seat: Suitable for 300 psig for Pumping Plant No. 4 and Pumping No. Plant 7.
  - f. Top of the valve to include the following features:
    - 1) Steel balance pipe inlet that lets air flow out of the air chamber through the air release pipe if the water surface in the air chamber reaches the AIR RELEASE level.
    - 2) Air discharge pipe as shown on the drawings.
    - 3) Minimum Orifice Size: 3/16-inch.
  - g. Two ball valves:
    - 1) One near top to permit checking effectiveness of air valve.
    - 2) One at bottom to allow valve to be drained.
  - h. Internal parts, such as guides, bushings, and screws: Stainless steel or bronze.
  - i. Floats: Stainless steel.
  - j. Float-pivot supports: Brass, bronze, stainless steel, or cast iron.
  - k. Minimum cold-water pressure rating for all parts: 300 pounds per square inch.
  - l. Internally threaded NPT as shown on the drawings.

S. Pressure Gauges:

1. Model 213.40 manufactured by Wika Instrument, LP, [www.wika.us](http://www.wika.us), Type 1279 manufactured by Ashcroft, Inc. [www.ashcroft.com](http://www.ashcroft.com); or equal, having the following essential characteristics:
  - a. Range displayed on gauge: 0 to 350 psi.
  - b. Bronze bourdon-tube, adjustable-movement type.
  - c. Case material: Brass, aluminum alloy, phenolic or stainless steel.
  - d. Dust-proof and moisture-proof case.
  - e. Glycerin liquid filled.
  - f. 4-inch to 4 1/2-inch diameter or larger dial.
  - g. Dial: White with black markings.
  - h. Black indicating pointer.
  - i. Red maximum reading pointer indicating highest pressure attained.
  - j. Shatter resistant window.
  - k. Conform to ASME B40.100, Grade A accuracy or better.

T. Mufflers:

1. Standard High-Pressure Muffler manufactured by Alwitco, [www.alwitco.com](http://www.alwitco.com); or equal, having the following essential characteristics:
  - a. Vents air from the compressor discharge or from inside the air chamber to atmosphere.
  - b. Does not freeze under any atmospheric conditions at the air chamber.
  - c. Silences noise due to the motion of air across the pressure differential.
2. Calculate and provide adequate diameter of muffler.

U. Globe Valves:

1. MSS SP-80.
2. Pressure rating: 300 psi.
3. Suitable for air service.
4. Suitable for throttling.
5. Suitable for use immediately upstream of muffler:
  - a. Valve diameter to match diameter of piping to muffler.

V. Check Valves:

1. Model 205 valve manufactured by Kingston Valves, [www.kinngstonvalves.com](http://www.kinngstonvalves.com); or equal, having the following essential characteristics:

- a. Valve disks and springs: Constructed of stainless steel.
  - b. Pressure rating: 300 pounds per square inch.
  - c. Specifically designed for air service, equal in size to the air compressor discharge.
  - d. For installation in the air compressor discharge line.
- W. Handholes: Provide handholes in accordance with ASME Section VIII Division 1 UG 11.
- X. Anchor Bolts:
1. Size, material, and number of anchor bolts for base of skirt: Determined by air chamber designer.
  2. Embedded in the air chamber foundation similar to that shown on the drawings.
    - a. "J" or "L" shaped ends are not acceptable.
- Y. Air Compressor Unit:
1. Single motor driven, air compressor unit.
  2. Rating:
    - a. Pumping Plant No. 4: Deliver between 40 and 45 inlet cubic feet per minute (minimum) of free air at 228 psig operating at elevation 5,900-feet, 102 degrees F and 15 percent relative humidity. One air compressor will supply air to four air chambers.
    - b. Pumping Plant No. 7: Deliver between 40 and 45 inlet cubic feet per minute (minimum) of free air at 251 psig operating at elevation 6,200-feet 102 degrees F and 15 percent relative humidity. One air compressor will supply air to four air chambers.
  3. Skid mounted.
  4. Sound attenuating enclosure:
    - a. Enclose the air compressor and motor inside a sound attenuating protective enclosure to limit the air compressor sound level to a maximum of 80 dBA (decibels A) when operating at normal operating pressure, including unloader blowoff:
      - 1) Verify maximum sound decibel level during compressor operation at normal working pressure, in a similar environment, with compressor manufacturer.
    - b. Sound attenuating protective enclosure is not required if compressor sound level does not exceed 80 dBA (decibels A) when operating at normal operating pressure, including unloader blowoff.
    - c. Steel materials.

- d. Provide louvered inlet to allow adequate air flow into the air compressor.
  - e. Enclosure to be removable for access to the air compressor and motor.
  - f. Anchor enclosure to the concrete pad.
5. Suitable for installation in the space shown on the drawings and with sufficient access and working space to permit ready and safe operation and maintenance.
  6. Complete with air compressor, motor, motor starter, automatic unloader, air filter, intake muffler, and necessary piping, valves, controls, and wiring.

Z. Air Compressor:

1. Model WP65L by Sauer Compressors, [www.sauerusa.com](http://www.sauerusa.com); or equal, having the following essential characteristics:
  - a. Reciprocating piston type, single acting, two-stage, pressure lubricated, air cooled.
  - b. Main shaft bearings: Ball or adjustable roller-bearing type with heavy-load capacity.
  - c. Provisions shall be made for positive lubrication of all moving parts with food grade oil.
  - d. Food grade synthetic compressor oil shall have a minimum average life of 4,000 hours.
  - e. Include low-oil-level shutdown switch with indicating light.
  - f. Automatic unloading device: Unloads compressor whenever motor stops and maintains this condition until motor is operating at full speed.
  - g. Capable of continuous operation at specified discharge pressure and capacity without overheating.

AA. Air Compressor Motors:

1. Designed for duties specified.
2. Horizontal squirrel-cage-induction type.
3. Conform to NEMA MG 1, including characteristics, tests, and ratings, unless otherwise specified.
4. Lifting eyes or devices for slings: Provided on motor for lifting.
5. Totally enclosed fan cooled (TEFC) enclosure.
6. Designed for across-the-line, full voltage starting.
7. Coordinate motor torque with torque requirements of load, so that proper operation of the unit will be obtained during the sequence of starting, accelerating, and normal running.
8. Rated: 460-volts, 3-phase, 60-hertz.

9. Horsepower rating: Motor will carry continuously the maximum possible compressor load developed under operating conditions specified, without exceeding nameplate rating, and without benefit of the service factor.
10. Maximum temperature rise of windings when motor is delivering rated output continuously at rated voltage and frequency: 80 degrees C by resistance for class F, or H insulation.
11. Temperature rise of other parts of motor: In accordance with NEMA MG 1 for class B insulation.
12. Stators:
  - a. Three main armature leads: Brought out of the stator frame to the terminal box, and each lead shall terminate in a bolted solderless connector.
  - b. Armature lead insulation: Completely sealed so that it is equal to the armature coil insulation in regard to resistance to moisture and voltage class.
  - c. Connection in terminal box to external leads: Taped.
13. Armature windings:
  - a. Insulated with class F or H insulation.
  - b. Insulation: Treated to prevent damage from temporary exposure to dampness.
14. Rotors:
  - a. Rotor structure: Built up in accordance with modern practice and provided with squirrel-cage windings of suitable resistance for starting the motor and compressor with the required starting voltage.
15. Bearings:
  - a. Antifriction bearings on each end of rotor.
  - b. Oil or grease lubricated.
  - c. Provided with facilities for draining lubricant and re-lubricating bearings without disturbing the bearing housing.
  - d. Self-cooled.
  - e. Sealed against loss of lubricant or entrance of dirt.
  - f. If a thrust load can occur in the motor, the bearings furnished shall be designed for the thrust load.
  - g. Designed so that in event of bearing failure the motor rotor cannot make contact with the stator core.

17. Motor: Painting and protective coating:
  - a. Paint exposed ferrous surfaces of motor in accordance with Section 09 96 20 – Coatings.
  - b. Internal ferrous surfaces of motor, including rotor: Finished with an applied protective covering of such composition as to effectively inhibit corrosion.
18. Controls: Provide following in addition to manufacturer's standard control devices:
  - a. Combination Motor Starter: Provide integrated safety disconnect rated appropriately for air compressor.
  - b. NEMA Type 12 enclosure for motor and compressor controls with equipment designation nameplate.
  - c. Motor Starter:
    - 1) Magnetic, full-voltage, NEMA type.
    - 2) Thermal motor overload relay.
    - 3) 120-volt, 60-hertz coil.
  - d. Mode Selector Switch:
    - 1) HAND-OFF-AUTO. In AUTO position air compressor is controlled by signals from the Air Chamber Surge Control Panel.
    - 2) Oil-tight, water-tight.
    - 3) NEMA ICS 5: A600 contact rating.
    - 4) Provide manufacturer's standard nameplate.
  - e. Elapsed time meter.
  - f. Conform to NEMA 250, NEMA ICS 2, and NEMA ICS 5.
19. Drive:
  - a. Reciprocating piston type: V-belt drive with totally enclosed guard or flange mount motor.
20. Baseplates:
  - a. Mount air compressor and motor on a common rigid cast-iron or structural-steel baseplate.
  - b. Suitable for anchoring to a concrete pedestal.
  - c. Designed to suit the unit furnished.
  - d. Provide leveling bolts on bottom of the baseplate.
21. Combination Air Intake Filter and Silencers:
  - a. Dry type.

- b. Filter:
    - 1) Disposable elements.
    - 2) Micron rating as recommended by air compressor manufacturer.
  - c. If the compressor discharge has a blowoff for unloading the compressor, a silencer shall be furnished to keep the air discharge noise level below 80 dBA, if possible.
22. Unloaders:
- a. Allows compressor motor to start and stop unloaded.
  - b. If a magnetic unloader is furnished: Suitable for use on a 120-volt, 60-hertz control circuit.
  - c. Pressure-regulating switch: Standard type, adjustable within an operating range of 80 to 110 percent of the pressure rating of its compressor.
  - d. Control equipment: Conform to the applicable standards of IEEE and NEMA.
23. Appurtenances:
- a. Furnish and install fasteners, lubricating devices, gaskets, and other appurtenances required to make the unit complete and ready for operation.
- BB. Automatic Drain Valve:
- 1. Electric Operated Condensate Drain Valve manufactured by Air Systems Products, [www.airsyspro.com](http://www.airsyspro.com); or equal, having the following essential characteristics:
    - a. Automatically removes moisture.
    - b. Suitable for pressures up to 300 psig.
- CC. Compressed Air Filtration System:
- 1. Each air compressor shall be furnished with an air filtration system that filters the air to ISO 8573.1, Quality class 1.2.1.
- DD. Oil/Water Condensate Collection System and Separator:
- 1. Plumbing system shall be provided to convey oil/water condensate from each filter element to an oil/water condensate separator.
  - 2. Collection system and oil/water separator shall be provided for each air compressor.
  - 3. Plumbing system will connect all filter drains to a Schedule 80 polyvinyl chloride (PVC) condensate manifold.
  - 4. Manifold will drain into the oil/water condensate separator.

5. Oil/water separator shall remove oil from the condensate so that the separated condensate can be conveyed to the plant drain without violation of federal, state and local environmental regulations.
6. Separated oil shall be held in a reservoir for proper disposal by the plant operators.

EE. Air Chamber Surge Control Panel:

1. Provide automatic adjustment of air chamber level by controlling the system air volume:
  - a. Control the automatic operation of the air compressor, air chamber emergency alarms, and pump shutdown:
    - 1) EMERGENCY PUMPS OFF (Main pumps are locked out and SCADA indicates an alarm condition when the water in the air chamber reaches this level in the tank).
    - 2) COMPRESSOR ON (Air compressor to start when the water in the air chamber reaches this level).
    - 3) COMPRESSOR OFF (Air compressor to stop when the water in the air chamber reaches this level).
    - 4) AIR RELEASE (SCADA indicates an alarm condition when the water in the air chamber reaches this level).
2. Alternating lead compressor operation. Alternating feature shall alternate air compressor upon each start up.
3. Communication protocol: Modbus RTU.

## 2.02 AIR CHAMBER FABRICATION

- A. Fabricate in accordance with Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code (BPVC).
- B. Stamp finished tank with official ASME code symbol.
- C. Air Chamber Weld Tests:
  1. Air chamber manufacturer shall maintain a quality-assurance program to ensure that minimum standards are met. It shall include an ASME Authorized Inspector to verify that welders and welding procedures are qualified, procedures are being followed within the limitations of testing, and quality assurance functions are being implemented.
  2. Radiograph all longitudinal and girth butt welds. COR will witness all weld tests.
  3. Radiograph in accordance with requirements of the ASME BPVC, unless otherwise provided for in these specifications.

4. Before radiographing weld, place suitable identification markers adjacent to weld. Paint, stamp, or fasten the markers to shell as directed by COR. Do not remove the markers until all welds in joint have been accepted.
5. In addition, provide temporary corresponding markers at each film location so that the images of these markers will appear on the radiographs.
6. Deliver radiographs to COR.
7. Authorized ASME Inspector will judge the acceptability of welded joints.
8. Repair defects in welds in accordance with requirements of the ASME Code.
9. Portions of welds that have been repaired are to be radiographed again.

### **2.03 CONTRACTOR SOURCE QUALITY TESTING**

#### **A. Air Chamber Hydrostatic Pressure Test:**

1. Perform hydrostatic pressure test in the shop or in the field as necessary. Provide Government 30-days' notice of shop test or 2-days' notice for field test.
2. Test before cleaning and painting.
3. Welded attachments to be connected to the air chamber prior to testing.
4. Test pressure: Per ASME BPVC, Section VIII, Division 1.
5. Provide all temporary supports, bulkheads, air vents, dead weight tester, and other equipment necessary to perform the hydrostatic tests.
6. Remove temporary supports before final placement of the air chamber on its base.
7. Provide equipment necessary to complete test.
8. Provide a minimum of two calibrated pressure gauges:
  - a. Upper limit of pressure gauges: 1.5 to 3 times required test pressure.
  - b. Accuracy: To within 1 percent of full scale.
  - c. One shall be recording type.
  - d. Gauges shall be calibrated within 30-days prior to use.
  - e. Calibrate pressure gauges with a deadweight tester. COR will witness calibration of pressure gauges.
9. Water for field test:
  - a. Obtain adequate supply of potable water, transport to the site, and dispose of the water after the test.
  - b. Temperature of test water, minimum: 45 degrees F.
10. Test procedure:
  - a. Fill air chamber with water.

- b. Uniformly increase pressure until required test pressure is reached.
  - c. Make time - pressure record of the hydrostatic pressure test.
  - d. COR will witness the hydrostatic test.
  - e. Apply and release test pressure three times.
  - f. Hold at required pressure each time until welded joints and seams can be examined. Hold time shall not be less than 15-minutes.
11. Repair defects, re-radiograph repairs, and retest air chamber.
  12. No welding permitted on air chamber after hydrostatic test has been accepted.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

#### **A. Air Chambers:**

1. Mount air chamber with supporting skirt on grout pad on concrete foundation.
2. Securely anchor with anchor bolts and chairs.
3. Install air chambers and equipment as shown on drawings.

#### **B. Air Compressors:**

1. Clean, reassemble, align, shim, and anchor air compressor unit in its final position on a 1 1/2-inch thick grout pad on the concrete foundation in accordance with manufacturer's installation instructions.
2. Install control and unloading devices, piping connections from air compressor unit to air chamber, gauge, and electrical connections to the compressor, motor starter, and control panel.

#### **C. Air Compressor Piping:**

1. Install pipe hangers and supports in accordance with ASME B31.1. Arrange piping supports so that no excessive bending stresses are induced into the piping from concentrated loads between supports. Install insulating material between dissimilar metals.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

#### **A. Provide Government 2-days' notice for field test.**

#### **B. Air Compressor Testing:**

1. Before making electrical connections and energizing compressor motor perform motor insulation resistance test as follows:
  - a. Use 500-volt megger. Apply test voltage for 1-minute.

- b. If no evidence of distress or insulation failure is observed and the insulation resistance reading is 5 megaohms or greater, the motor is considered to have passed the test.
    - c. Test in accordance with IEEE 43.
    - d. If the motor fails the test, correct in accordance with manufacturer's recommendations subject to approval of COR.
  2. After the air compressor unit and associated piping and control equipment have been installed, test in accordance with manufacturer's operating instruction to determine that it operates properly.
  3. Run-in period:
    - a. Operate compressor without load for a period of not less than 1 hour.
    - b. During operation and after shutdown, observe to determine that parts are in proper alignment, are receiving correct lubrication, and there is no undue heating, as recommended by the manufacturer.
    - c. Test control system and make necessary adjustments to ensure proper operation of compressor.
    - d. Repair or replace wiring or equipment damaged during installation or in checkout process.
    - e. Set and test switch devices on level indicating and switch module assembly to provide high and low level alarms.
    - f. Set and test Air Chamber Surge Control Panel.
    - g. Set and test differential pressure transmitter to start compressor when water level in air chamber is at COMPRESSOR ON level, and to stop compressor when water level in air chamber is at COMPRESSOR OFF level when operating under start stop (AUTO) control.
    - h. Without additional cost to Government, make necessary adjustments until operation of the unit is approved.
  4. Pneumatic leakage testing:
    - a. Perform testing on air compressor piping, air equalization piping and high pressure sensing line piping.
    - b. Preliminary test:
      - 1) Apply a pressure of 10 psi to reveal major leaks. Vent pressure, make appropriate repairs and repeat test.
    - c. Leakage testing:
      - 1) Raise pressure in stages of not more than 25 percent of normal operating pressure. Allow time between stages for the piping to equalize and to detect leaks at each stage.

- 2) When normal operating pressure is reached, hold pressure for 10-minutes and examine piping for leaks.
- 3) If leaks are found, vent pressure, make appropriate repairs and repeat test.
- 4) Leaks may be detected by soap bubble, scented gas, ultrasonic or other suitable means.

### **3.03 COATING**

- A. Coat in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

**SECTION 33 16 40**  
**WATER STORAGE TANKS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Water Storage Tanks:

1. Payment: Lump sum prices offered in the Price Schedules:
  - a. Includes:
    - 1) Designing, providing tank testing and tank foundation, and associated equipment.
    - 2) Waterstops.

**1.02 REFERENCE STANDARDS**

A. American Institute of Steel Construction (AISC)

1. AISC 360-16 Specifications for Structural Steel Buildings

B. American National Standards Institute (ANSI)

1. ANSI A14.3-2008 Ladders – Fixed – Safety Requirements
2. ANSI A1264.1-2017 Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail Systems
3. ANSI/NSF 61-17 Drinking Water System Components – Health Effects
4. ANSI/NSF 372-16 Drinking Water System Components – Lead Content

C. ASTM International (ASTM)

1. ASTM D1785-15e1 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D. American Water Works Association (AWWA)

1. AWWA C652-11 Disinfection of Water-Storage Facilities
2. AWWA D100-11 Welded Steel Tanks for Water Storage
3. AWWA D103-09 Factory-Coated Bolted Steel Tanks for Water Storage

- 4. AWWA D110-13 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks
- 5. AWWA D115-17 Tendon-Prestressed Concrete Water Tanks
- E. American Welding Society
  - 1. AWS D1.1/D1.1M:2015 Structural Welding Code - Steel
- F. Code of Federal Regulations (CFR)
  - 1. 29 CFR Part 1910, Subpart D Occupational Safety and Health Administration (OSHA) Standards – Walking-Working Surfaces
- G. Environmental Protection Agency (EPA)
  - 1. How to Conduct a Sanitary Survey of Drinking Water Systems-2016
- H. Federal Acquisition Regulations FAR)
  - 1. FAR 52.246-21 Warranty of Construction
- I. International Code Council (ICC)
  - 1. IBC-2015 International Building Code

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 33 16 40-1, Designer, Erection Engineer and Contractor Qualifications.
- C. RSN 33 16 40-2, Commercial Products Data:
  - 1. Data for the following:
    - a. Pipe clamps if commercial products used.
    - b. Ladders, guardrails, fall protection system, guard door, and other safety related appurtenances:
      - 1) Anchorage components, including nuts and washers.
    - c. Submersible pressure transmitter.
    - d. Liquid level indicator.
    - e. Modular seals.
- D. RSN 33 16 40-3, Approval Drawings:
  - 1. Submit checked shop and installation drawings for ladders, guardrails, fall protection system, guard door, and other safety related appurtenances.

2. Submit checked, detailed shop drawings including dimensions and tolerances, material data, joint details, and welding requirements for the water quality sampling systems at Pumping Plant No. 4 and Pumping Plant No. 7.
  3. In Government Format in accordance with Section 01 33 00 – Submittals.
    - a. Include the following on shop and installation drawings:
      - 1) Show controlling dimensions.
      - 2) Show details of component members and connections.
      - 3) Show type and grade of material, and type of finish.
    - b. Include set of plans and elevations.
    - c. Show details and methods of installation and anchoring.
    - d. Show members, sizes and thicknesses, anchorage locations, and accessory items.
    - e. All field connections shall be clearly marked and noted on shop drawings, indicating size of required fasteners and their locations.
- E. RSN 33 16 40-4, Calculations:
1. Submit calculations detailing the design of pipe supports and tank appurtenances.
    - a. Analysis detailing loading and corresponding stresses on all tank appurtenances.
    - b. Indicated compliance with the design requirements in 1.04, Design Requirements.
    - c. Sealed by a professional engineer registered in the State of New Mexico.
  2. Submit calculations detailing structural design of:
    - a. Ladders, guardrails, and other safety related appurtenances.
    - b. Overflow pipe supports attached to the tank and foundation.
    - c. Overflow weir box supports.
    - d. Overflow weir box design and weir box supports.
    - e. Stand pipe and stand pipe supports attached to tank wall including buoyancy.
    - f. Indicate compliance with the design requirements in Article 1.04 Design Requirements.
    - g. Sealed by a professional structural engineer registered in the State of New Mexico.
- F. RSN 33 16 40-5, Final Drawings and Data:
1. In Government Format in accordance with Section 01 33 00 – Submittals.
  2. Complete set of As-built drawings:

- a. Clearly mark drawings 1695-D-60595 through 1695-D-60620 to show final installation. Include all field modifications.
  - b. Include drawings for ladders, guardrails, fall protection system, guard door, and other safety related appurtenances.
  - c. Submit drawings in accordance with Section 01 78 30 – Project Record Documents.
3. Service Manuals:
- a. Submersible pressure transmitter.
  - b. Tank mixer.

#### 1.04 DESIGN REQUIREMENTS

##### A. General:

1. Meet sanitation guidelines recommended by US EPA Publication - How to Conduct a Sanitary Survey of Drinking Water Systems:
  - a. Chapter 10 finished water storage facility.
2. Water Storage Tank:
  - a. Liquid volume:
    - 1) Pumping Plant No. 4: 1 million gallons (MG).
    - 2) Pumping Plant No. 7: 1.5 million gallons (MG).
3. Design to comply with NSF 61 and NSF 372 requirements.
4. Materials suitable for free chlorine residual exposure:
  - a. Typical free chlorine residual concentration in tank: Up to 4 milligrams per liter (mg/l).
5. Vent sizing:
  - a. Pumping Plant No. 4: Size vent for an inlet/withdrawal ~~inlet~~ rate of 51.5 cubic feet per second (cfs).
  - b. Pumping Plant No. 7: Size vent for an inlet/withdrawal rate of 47.7 cfs.
  - c. Differential pressure across vent shall be within acceptable range as determined by tank manufacturer.
6. Refer to drawings for dimensions, elevations, tank venting, pipe penetrations, access hatches, and piping.
7. Vent on top of tank shall be a minimum of 24-inches above the surface of the tank roof.
8. Hatch on top of tank shall be a minimum 4-inches above the surface of the tank roof.
9. Account for openings and penetrations through tank elements:

- a. Modular seals not permitted for tank floor penetrations.
  10. Design, furnish, and install pipe supports and brackets attached to the tank.
  11. Design to comply with OSHA requirements.
  12. Dielectrically isolate dissimilar metals.
  13. Design for seismic loading.
- B. Foundation:
1. Coordinate design of tank and foundations.
  2. Design foundations with the centroids of superimposed loads at their actual locations.
  3. Refer to Sections 53 10 00 – Geological Investigations and 31 23 10 – Earthwork for foundation subgrade conditions.
  4. Foundation shall be an on-grade structure. Bearing on subgrade as indicated on the drawings.
  5. Foundation designed to support tank, equipment, accessories and overflow piping.
- C. Ladders and Guardrails:
1. Designed to meet the load requirements as prescribed by 29 CFR Part 1910 Subpart D, ANSI A14.3, and ANSI A1264.1.
  2. Designed for dead, live, and any combination of loads thereof, in accordance with the IBC.
  3. Designed and fabricated in accordance with the applicable requirements in AISC 360.
  4. Materials and welding shall conform to all applicable requirements of ASIC 360.
  5. Provide exterior ladder from the bottom of the shell to the roof including side rails.
  6. Provide a hinged, lockable, guard door over the bottom of the ladder.
  7. Provide guardrail around the perimeter of the tank roof as indicated on drawings.
    - a. Provide additional guardrails and/or platforms, as required, to access appurtenances installed on the tank roof.
  8. Ladders:
    - a. Provide an exterior ladder from bottom of tank shell to roof of tank as indicated on drawings.
    - b. Provide a hinged, lockable, guard door gate over bottom of the ladder with minimum height of 8-feet.
    - c. Provide a lockable roof hatch with rubber sealing gasket.
    - d. Provide ladder side rails fabricated out of steel pipe.

- e. Provide ladder rungs with a raised tread pattern.
  - f. Provide a fall arrest system on ladder and safety rail extension.
  - g. Detail ladder including steps and rungs, side rails, and ladder termination in accordance with ANSI A14.3.
9. Railings:
- a. Provide railings surrounding roofs of tanks as indicated on drawings.
  - b. Provide railings with a top rail, an intermediate rail, and a kick plate.
  - c. Railing height: 42-inches minimum.
  - d. Detail railings in accordance with ANSI 14.3 and ANSI A1264.1.
- D. Water Quality Sampling System:
- 1. Provide complete water quality sampling systems for Pumping Plant No. 4 and for Pumping Plant No. 7 as shown on drawings 1695-D-60622 through 1695-D-60624.
  - 2. Piping and other equipment in accordance with Section 35 21 95 – Steel Manifold Piping.
  - 3. Valves and other equipment in accordance with Section 35 22 14 – Valves and Equipment.

## **1.05 QUALIFICATIONS**

- A. Tank and Foundation Designer Qualifications: Professional Structural Engineer registered in the State of New Mexico.
- B. Erection Engineer:
- 1. Specializes in construction of applicable tank type selected.
  - 2. Minimum 3-years' experience in the design, fabrication, and erection of water storage and surge tanks using the applicable AWWA, ASME, AWS, ANSI/NSF and OSHA standards.
- C. Tank and Tank Foundation Designer: Designed at least 5 similar projects:
- 1. Designer of Tank: Professional Structural Engineer registered in the State of New Mexico, with a minimum of 5-years' experience designing tanks.
  - 2. Designer of Tank Foundation: Professional Structural Engineer registered in the State of New Mexico, with a minimum of 5-years' experience designing reinforced concrete foundations.
- D. Installer: Installed at least 5 similar tank projects.
- E. Manufacturer: Manufactured at least 5 similar tank projects:

1. Certified welders in accordance with AWS D1.1 using procedures, materials, and equipment of the type required for work.

F. Contractor: Installed at least 5 water and or waste water tanks.

## 1.06 WARRANTY

- A. Warrant tank for extended period in accordance with the clause at FAR 52.246-21, Warranty of Construction.

## PART 2 PRODUCTS

### 2.01 TANK OPTIONS

- A. In accordance with Table 33 16 40A - Tank Options.

Table 33 16 40A - Tank Options

Tank Designation	Options Allowed	Section
Welded Steel Tank	AWWA D100	33 16 50 – Steel Tank
Bolted Steel Tank	AWWA D103	33 16 50 – Steel Tank
Concrete Wire Wrapped	AWWA D110	33 16 51 – Concrete Wire Wrapped Tank
Concrete Prestressed	AWWA D115	33 16 52 – Concrete Prestressed Tank

### 2.02 PIPE, FITTINGS, AND ACCESSORIES

- A. Standard and Schedule Steel Pipe:
  1. Steel piping, flanges, fittings, couplings, gaskets and accessories in accordance with 35 21 95 – Steel Manifold Piping and as indicated on drawings.
- B. Polyvinyl Chloride Pipe: ASTM D1785.
- C. Stand Pipe Support Brackets:
  1. Corrosion resistant materials.
  2. Galvanized steel not allowed.
- D. Valves and Equipment:
  1. Valves in accordance with 35 22 14 – Valves and Equipment and as indicated on drawings.

2. ANSI/NSF 61 certified.
  3. ANSI/NSF 372 certified lead-free.
  4. Suitable for potable water.
  5. Materials suitable for free chlorine exposure:
    - a. Typical free chlorine concentration: Maximum 4 milligrams per liter (mg/l).
- E. Valves and Piping Enclosure at Pumping Plant No. 4:
- a. Enclosure contains chlorine injection valving. See drawings 1695-D-60615 and 1695-D-60476.
  - b. Size enclosure to accommodate chlorine injection valving.
  - c. Bottom of enclosure to be at ground surface to minimize air exposure of piping entering from bottom of enclosure.
  - d. Coordinate enclosure mounting to side of tank with tank manufacturer:
    - 1) No tank penetrations (bolt holes through the tank or similar) are allowed.
  - e. 14 gauge stainless steel.
  - f. Seams continuous welded and ground smooth.
  - g. Heavy-gauge continuous hinge pin.
  - h. Formed external return flanges around all sides of enclosure opening.
  - i. Hasp and staple for padlocking.
  - j. Stainless steel screws and clamps.
  - k. Insulated and gasketed.
  - l. Cabinet temperature controller and heater:
    - 1) 120-volt, 60 hz.
    - 2) External sensor: RTD or Thermocouple.
    - 3) Low temperature alarm contact for connection to Supervisory and Control Data Acquisition (SCADA) system.
    - 4) Cabinet heater for outdoor installation in temperatures ranging down to -15 degrees F.
  - m. Insulate exposed piping between bottom of enclosure and ground surface.
- F. Submersible Pressure Transmitter: Druck PTX 1800 series submersible pressure sensor by GE, GE Measurement and Control, [www.gemeasurement.com](http://www.gemeasurement.com). PX438 submersible water level transmitter by OMEGA Engineering, [www.omega.com](http://www.omega.com); or equal, having the following essential characteristics:
1. Silicon pressure element or piezoelectric.

2. Fully sealed stainless steel or titanium body.
  3. Cable:
    - a. Polyurethane cable with vent.
    - b. Length: 40-feet.
  4. Output shall be 4-20 milliamperes DC.
  5. Transmitter shall be suitable for operation on 9 to 30 volt DC external power supply.
  6. Adjustable offset (zero) and span shall be provided.
  7. Minimum Accuracy: Plus or minus 0.25 percent.
  8. Isolating diaphragm: 316L stainless steel or titanium.
  9. Include:
    - a. Cable clamps suitable for proper support of suspended sensor.
    - b. Sink weights or anchor assembly.
    - c. Sensor termination enclosure.
  10. Transmitter and transmitter accessory materials in contact with potable water shall be National Sanitation Foundation listed.
  11. Provide calibration equipment as required.
  12. Transient Protector:
    - a. Protects pressure transmitter from damage due to lightning and switching surges.
    - b. Compatible with pressure transmitter output of 4 to 20 milliamperes.
- G. Liquid Level Indicator:
1. Model 92302, as manufactured by Shand & Jurs (L & J Technologies), [www.ljtechnologies.com](http://www.ljtechnologies.com); or equal, having the following essential characteristics:
    - a. Float-actuated level gauging system consisting of a target sliding vertically over an aluminum gauge board.
    - b. Gauge board graduated in feet and inches with numerals at each foot with highest reading at ground level.
    - c. Type 316 stainless steel for float, cable, and guide wires.
    - d. At least three gauge board support brackets to match tank material type.
    - e. Liquid seal.
    - f. True reading pulley system.
- H. Fall Arrest System:

1. Miller Saf-T-Climb as manufactured by Honeywell, 1345 15<sup>th</sup> St., Franklin, PA 16323; or equal, having following essential characteristics:
  - a. Round cross section.
  - b. Allow sleeve to swing completely around when climber reaches the top, to allow the climber to step onto the top of the tank without disconnecting the sleeve.
  - c. Flat safety rail: Not acceptable.
  - d. Provide one sleeve and belt with tank.

I. Ladders:

1. Metal safety steps for ladders: “Tread-Grip” No. 11-gauge sheet steel ladder rungs, manufactured by Metalex, Unit of Jason Incorporated, [www.metlx.com](http://www.metlx.com), “Traction Tread” steel ladder rungs manufactured by Eaton, [www.eaton.com](http://www.eaton.com). One inch-square “Mebac” solid steel ladder rungs, manufactured by Harsco Industrial IKG, [www.mebac.com](http://www.mebac.com); or equal, having following essential characteristics:
  - a. Concentrated design load at center of rung of at least 250-pounds.
  - b. Raised button, serrated-edge, or metal bonded encapsulated grit surface.
2. Guard door over the bottom of the ladder:
  - a. Minimum of 96-inch tall solid panel.
  - b. Steel construction.
  - c. Heavy duty continuous piano hinge to allow cover easily swing to the side for ladder access.
  - d. Lockable with a padlock shackle up to 7/16-inch diameter.
  - e. Locate locking mechanism 24- to 36-inch above top of tank foundation.

J. Ladder Safety Gate:

1. Kee Safety Self-Closing Safety Gate manufactured by Kee Safety Limited, [www.keesafety.co.uk](http://www.keesafety.co.uk); or equal, having the following essential characteristics:
  - a. OSHA compliant.
  - b. Spring loaded to automatically close behind the user.
  - c. Material: galvanized steel.

K. Guardrail:

1. Rails: 1 1/2-inch standard steel pipe or Schedule 80 aluminum 6061-T6 or 6005-T5 anodized aluminum pipe.
2. 3-rail with equally spaced rails and a 4-inch high toe board (kick plate).
3. Minimum height: 42-inches above walking surface.

4. Maximum post spacing: 8-feet.
  5. Maximum gap between adjacent guardrail sections: 4-inches.
  6. Coordinate guardrail fittings with selected rail material.
  7. Insulate rail connections from the tank as required to prevent contact with dissimilar metals and/or other tank materials.
- L. Secure Roof Vent:
1. Model AST-Vent manufactured by Advance Tank Construction Co., [www.advancetank.com](http://www.advancetank.com); or equal, having the following essential characteristics:
    - a. AWWA D100 compliant.
    - b. Lockable.
    - c. Vent entrance minimum 24-inches above top of tank.
    - d. Protective #24 mesh screen to keep out insects.
    - e. Frost proof.
- M. Lockable roof hatch with rubber sealing gasket.
- N. Modular Seals:
1. Model S61 manufactured by Link Seal (GPT an EnPro Industries company), [www.gptindustries.com](http://www.gptindustries.com); or equal, having the following essential characteristics:
    - a. ANSI/NSF 61 certified for use in potable water.
    - b. Seal element: Black EPDM.
    - c. Pressure plates: Reinforced nylon.
    - d. Bolts and nuts: Type 316 stainless steel.
    - e. Temp. Range: -40 to 250 degrees F (-40 to 121 degrees C).
  2. Galvanized steel pipe sleeves for concrete tank side penetrations to be provided by seal manufacturer to match wall thickness, size of pipe penetrating tank and associated modular seal.
- O. Spare Overflow Screen Flange: Provide one stainless steel mesh screen flange as shown on drawing 1695-D-60618.
- P. Mixer: See Section 46 33 00 – Sodium Hypochlorite Feed System for mixer specifications.
- Q. Steel Tank Cathodic Protection:
1. See 26 42 11 – Submerged Galvanic Anode Cathodic Protection System for Welded Tank Options.

## **PART 3 EXECUTION**

### **3.01 SERVICES OF ON-SITE ERECTION ENGINEER**

- A. Furnish the services of an on-site erection engineer to supervise and be responsible for erecting the storage tank. Have erection engineer onsite during water tank installation.

### **3.02 INSTALLATION**

- A. Install inlet, outlet, and drain and overflow piping in accordance with drawings 1695-D-60595 through 1695-D-60624 Section 35 21 95 – Steel Manifold Piping and Section 35 22 14 – Valves and Equipment:
- B. Provide supports and bracing as required to hold the steel and stainless steel pipe in place and prevent distortion during erection, placing of concrete, and backfilling.
- C. Install water quality sampling systems for Pumping Plant No. 4 and Pumping Plant No. 7 in accordance with drawings 1695-D-60622 through 1695-D-60624, Section 35 21 95 – Steel Manifold Piping and Section 35 22 14 – Valves and Equipment.
- D. Install valves, equipment and accessories according to manufacturer's instructions.
- E. Install tank in accordance with appropriate section for proposed tank option.
- F. Sterilize the completed tank using solution containing 200 ppm of chlorine in accordance with AWWA C652.
- G. Coordinate the work of the erection engineer with COR.
- H. Install ladders, and railings in accordance with approved manufacturer's installation drawings.

**END OF SECTION**

**SECTION 33 16 50**  
**STEEL TANKS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost:

1. In accordance with Section 33 16 40 – Water Storage Tanks.

**1.02 REFERENCE STANDARDS**

A. American Concrete Institute (ACI)

1. ACI 318-14 Building Code Requirements for Structural Concrete & Commentary

B. ASTM International (ASTM)

1. ASTM A36/A36M-14 Carbon Structural Steel
2. ASTM A307-14e1 Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength

C. American Welding Society (AWS)

1. AWS D1.1/D1.1M:2015 Structural Welding Code - Steel

D. American Water Works Association (AWWA)

1. AWWA C200-17 Steel Water Pipe, 6 In. (150 mm) and Larger
2. AWWA D100-11 Welded Steel Tanks for Water Storage
3. AWWA D103-09 Factory-Coated Bolted Steel Tanks for Water Storage

**1.03 SUBMITTALS**

A. Submit the following in accordance with the requirements of Section 01 33 00 – Submittals.

B. RSN 33 16 50-1, Shop Drawings, Design Calculations and Design Data Stamped and Signed By a Professional Engineer registered in the State of New Mexico:

1. Design calculations for steel tank including design and details of safety features.
2. Design calculations for reinforced concrete foundation including:
  - a. List of loading criteria and values, specific code references and load combinations.

- b. Magnitude and direction of steel tank base reactions and anchor bolt loading.
    - c. Maximum bearing pressures.
  - 3. Checked, detailed shop drawings which include dimensions, tolerances, material data, joint details and welding requirements.
    - a. Include details of contractor designed dielectrically isolated connection of stainless-steel water quality sample pipe to bottom of welded steel tank.
  - 4. Detailed design drawings of reinforced concrete foundation including:
    - a. Concrete foundation layout, elevations and dimensions.
    - b. Typical sections through the ringwall foundation.
    - c. Steel reinforcement details and sizes including bar lengths, location of construction joints and lap splices.
    - d. Anchor bolt setting plan including size, location and projection of anchor bolts, base mounting details, grout and sand cushion.
  - 5. Detailed manufacturer's instructions for erection of tank, including:
    - a. Details on bolting.
    - b. Placement of gaskets and/or sealants.
    - c. Coating repair procedures.
    - d. Assembly procedures.
- C. RSN 33 16 50-2, Nondestructive Weld Test Reports:
- 1. Nondestructive weld test reports for steel tank.

#### **1.04 DESIGN REQUIREMENTS**

- A. Design, fabricate, erect, inspect and test a flat-bottom steel tank for potable water storage, including appurtenances, braces, and structural members in accordance with AWWA D100 or AWWA D103, this section, and as shown on drawings and in accordance with Section 33 16 40 Water Storage Tanks:
  - 1. Wind and earthquake loads: See drawing 1695-D-60399.
  - 2. Provide roof in accordance with this section and drawings:
    - a. Structurally supported aluminum dome roof not permitted.
  - 3. For welded steel tanks, provide sand cushion required for supporting the welded steel tank bottom in accordance with AWWA D100 and as recommended by the tank manufacturer.
  - 4. For bolted steel tanks, provide a concrete-bottom tank designed and supported in accordance with AWWA D103.

5. Design and provide the diameter and number of anchor bolts required for the tank. Minimum anchor bolt diameter shall be not less than 1 1/4-inches. Provide anchor bolt chairs for the anchor bolts.
  6. Fabricate steel pipe in accordance with this section, Section 35 21 95 – Steel Manifold Piping, as indicated on drawings, and in accordance with AWWA C200.
  7. Design and furnish overflow weir in accordance with AWWA D100 for welded steel tanks and AWWA D103 for bolted steel tanks:
    - a. Overflow pipe diameter shall be as shown on drawings.
  8. Route output from pressure transmitter to COR's designated location.
- B. Design and construct a reinforced concrete foundation for a flat-bottom steel tank in accordance with AWWA D100 or AWWA D103, this section and as shown on drawings:
1. Thick cane-fiber joint filler not permitted.
  2. AWWA D100 welded steel tanks:
    - a. Design reinforced concrete ringwall foundation to support the steel tank and collateral loads imposed by equipment, accessories and overflow piping to be supported by the steel tank in accordance with ACI 318.
    - b. Provide grouted base ring and clean sand cushion.
    - c. Sand cushion resistivity of sand shall be greater than 3,000 ohm-cm when saturated with distilled or deionized water, a chloride content less than 100 ppm, and sulfate content less than 200 ppm. Hydrated lime may be added to the sand to increase the PH in accordance with AWWA D100.
    - d. Tank foundation drain to be installed under tank floor. See Drawing 1695-D-60442 and 1695-D-60443.
  3. AWWA D103 bolted steel tanks:
    - a. Design reinforced concrete tank foundation Type 6, concrete-bottom tank with embedded steel base setting ring, to support the steel tank and collateral loads imposed by equipment, accessories, and overflow piping to be supported by the steel tank in accordance with ACI 318.
    - b. Tank foundation drain to be installed under ~~concrete~~ tank floor. See Drawing 1695-D-60442 and 1695-D-60443.
  4. Concrete design and placement in accordance with Section 03 30 00 – Cast-in-Place Concrete.
  5. Grout design and placement in accordance with Section 03 63 00 – Epoxy Grout.
- C. Design and construct proper reinforcements for pipe penetration as shown on drawings.
- D. Contractor to design dielectrically isolated connection of stainless-steel water quality sample pipe to bottom of welded steel tank. Coordinate design with welded steel tank manufacturer.

## **PART 2 PRODUCTS**

### **2.01 EQUIPMENT**

- A. Anchor Bolts:
1. Bolts: ASTM A307, Grade B.
  2. Rods: ASTM A36.
  3. Studs with injection adhesive or capsule adhesive.
  4. Adhesive: HIT-HY 200 epoxy adhesive manufactured by Hilti Corporation, [www.hilti.com](http://www.hilti.com); or equal, having the following essential characteristics:
    - a. Stud and epoxy combination to be furnished by same manufacturer.
    - b. End of stud: Double cut point.

### **2.02 FITTINGS AND ACCESSORIES**

- A. Standard and Schedule Steel Pipe:
1. Steel piping, fittings, No. 24 stainless steel mesh screen and accessories in accordance with 35 21 95 – Steel Manifold Piping and as indicated on drawings.

### **2.03 SOURCE QUALITY ASSURANCE**

- A. Government retains the right to witness factory inspections.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Follow tank manufacturer's erection procedures.
- B. Welding procedures shall be in accordance with AWS D1.1 and AWWA D100 or AWWA D103:
1. Make available, to COR upon request, certification that welds were made by AWS qualified welders and inspected according to AWS standards.
  2. Surfaces to be welded shall be free from loose scale, slag, heavy rust, grease, paint, and other foreign material. Make surfaces smooth, uniform, and free from defects that adversely affect proper welding.
  3. Clean surfaces and remove weld scale or slag prior to coating.
- C. Welded Joints:
1. In accordance with AWWA D100 or AWWA D103.

- D. Bolted Joints:
  - 1. In accordance with AWWA D100 or AWWA D103.
- E. Provide steel pipe supports and bracing to hold steel pipe in place and prevent distortion during erection, placing of concrete, and backfilling.

### **3.02 INSPECTION**

- A. Coatings:
  - 1. Visibly inspect coatings.
  - 2. Repair damage to factory applied coatings compliance with erection instructions.
  - 3. Make available, upon request to the COR, certified test data on coating thickness.

### **3.03 CONTRACTOR FIELD QUALITY TESTING**

- A. Hydrostatically test tank in accordance with AWWA D100 or AWWA D103.
  - 1. Repair leaks in the tank in accordance with manufacturer's recommendations.
  - 2. Notify COR 5-days prior to test.
- B. Testing of welds:
  - 1. Employ requirements for radiographic testing for welded-shell butt-joints.
  - 2. Employ requirements for ultrasonic testing for groove welds.

### **3.04 SERVICES OF ON-SITE ERECTION ENGINEER**

- A. Erection engineer shall supervise and be responsible for erecting the steel tank. Erection engineer shall be onsite during installation phases of steel tank.
- B. Do not place concrete floor and foundation until subgrade is approved by Erection Engineer.
- C. Coordinate work of Erection Engineer with COR.

### **3.05 COATINGS**

- A. In accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

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**SECTION 33 16 51**  
**CONCRETE WIRE WRAPPED TANK**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost: In accordance with Section 33 16 40 – Water Storage Tanks.

**1.02 REFERENCE STANDARDS**

A. America Concrete Institute (ACI)

- |    |              |   |
|----|--------------|---|
| 1. | ACI 350-06   | Building Code Requirements for Environmental Engineering Concrete Structures                  |
| 2. | ACI 350.1-10 | Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary |
| 3. | ACI 350.3-06 | Seismic Design of Liquid-Containing Concrete Structures and Commentary                        |
| 4. | ACI 372-03   | Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures  |
| 5. | ACI 506R-05  | Guide to Shotcrete  |
| 6. | ACI 506.2-95 | Shotcrete   |

B. American Society of Civil Engineers (ASCE)

- |    |           |   |
|----|-----------|---|
| 1. | ASCE 7-05 | Minimum Design Load for Buildings and Other Structures. |
|----|-----------|---|

C. ASTM International (ASTM)

- |    |                          |  |
|----|--------------------------|--|
| 1. | ASTM A185/A185M-07       | Steel Welded Wire Reinforcement, Plain, for Concrete         |
| 2. | ASTM A227/A227M-06(2011) | Steel Wire, Cold-Drawn for Mechanical Springs                |
| 3. | ASTM A416/A416M-12a      | Steel Strand, Uncoated Seven-Wire for Prestressed Concrete   |
| 4. | ASTM A421/A421M-10       | Uncoated Stress-Relieved Steel Wire for Prestressed Concrete |
| 5. | ASTM A475-03(2009)       | Zinc-Coated Steel Wire Strand.                               |

- |  |                             |  |
|--|-----------------------------|--|
| 6.   | ASTM A497/A497M-07          | Steel Welded Wire Reinforcement, Deformed, for Concrete  |
| 7.   | ASTM A586-04a(2009)         | Zinc-Coated Parallel and Helical Steel Wire Structural Strand  |
| 8.   | ASTM A603-98(2009)          | Zinc-Coated Steel Structural Wire Rope   |
| 9.   | ASTM A648-12                | Steel Wire, Hard-Drawn for Prestressed Concrete Pipe.  |
| 10.  | ASTM A653/A653M-11          | Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process  |
| 11.  | ASTM A722/A 22M-12          | Uncoated High-Strength Steel Bars for Prestressing Concrete  |
| 12.  | ASTM A821/A821M-10          | Steel Wire, Hard-Drawn for Prestressed Concrete Tanks  |
| 13.  | ASTM A882/A882M-04a(2010)   | Filled Epoxy-Coated Seven-Wire Prestressing Steel Strand   |
| 14.  | <u>ASTM A1008/A1008M-16</u> | <u>Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable</u> |
| 15.  | ASTM C881/C881M-10          | Epoxy-Resin-Base Bonding Systems for Concrete  |
| 16.  | ASTM D1056-07               | Flexible Cellular Materials—Sponge or Expanded Rubber  |
| 17.  | ASTM D1752-04a(2008)        | Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction  |
| 18.  | ASTM D2000-12               | Standard Classification System for Rubber Products in Automotive Applications.   |
| 19.  | ASTM D2240-05(2010)         | Standard Test Method for Rubber Property - Durometer Hardness.   |
| D. American Water Works Association (AWWA) |                             |  |
| 1.   | AWWA D110-04                | Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks   |
| E. International Building Code (IBC)       |                             |  |
| 1.   | IBC 2009                    | International Building Code (IBC).   |

- F. Occupational, Health and Safety Administration (OSHA)
- G. Post Tensioning Institute (PTI)
  - 1. PTI DC10.7-83 Post-Tensioned Commercial and Industrial Floors
  - 2. PTI TAB.1-06 Post-Tensioning Manual, Sixth Edition
  - 3. PTI DC20.8-04 Design of Post-Tensioned Slabs Using Unbonded Tendons
  - 4. PTI M10.2-00 Specification for Unbonded Single Strand Tendons
  - 5. PTI M10.3-00 Field Procedures Manual for Unbonded Single Strand Tendons
  - 6. PTI M50.3-12 Specification for Grouting of Post-Tensioned Structures
  - 7. PTI CRT20 Manual for Certification of Plants Producing Unbonded Single Strand Tendons, Sixth Edition.

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 33 16 51-1, Approval Drawings and Data:
  - 1. Shop drawings:
    - a. Show all details that shall be used in the fabrication of tank components and tank construction.
  - 2. Manufacturer's installation instructions.
  - 3. Tank surface finishes and coating materials.
  - 4. Concrete design mixes, including shotcrete.
  - 5. Structural design calculations or analyses sealed by a professional engineer registered in the State of New Mexico.
  - 6. Provide 2- by 2-foot area of shotcrete finishes to be used as the standard for acceptance of installed construction.
- C. RSN 33 16 51-2, Test Reports:
  - 1. Submit certified mill test reports indicating ultimate and yield strength of all reinforcing bars, prestressing and post tensioning steel, and any other steel components.

- D. RSN 33 16 51-3, Documentation:
  - 1. Furnish applicable "Affidavits of Compliance" to building codes.
- E. RSN 33 16 51-4, Final Drawings and Data:
  - 1. Submit final drawings and data consisting of approved detailed shop drawings.
  - 2. Submit Operation and Maintenance Manuals.

#### 1.04 DESIGN REQUIREMENTS

- A. Tank:
  - 1. Refer to Section 33 16 40 – Water Storage Tanks.
  - 2. Design one of the following in accordance with ACI 350, and AWWA D110:
    - a. Type I: Cast-In-Place Concrete with Vertical Prestressed Reinforcement.
    - b. Type II: Shotcrete with a Steel Diaphragm.
    - c. Type III: Precast Concrete with Steel Diaphragm.
  - 3. Design floor and roof for single concrete placements, no joints are allowed.
  - 4. Floor design shall take into account concentrated loads from the roof column supports.
  - 5. Perimeter wall shall be wire-wound and vertically prestressed as applicable. If cast in place, full-height placements not to exceed 75-feet in length.
  - 6. Design core wall for initial compressive forces applied by prestressing and other applicable loadings.
  - 7. Tank foundation drain to be installed under tank floor. See Drawing 1695-D-60442 and 1695-D-60443.
- B. Earthquake resistance based on ACI 350.3 and the requirements of AWWA D110.
- C. Base design on AWWA D110 and ACI 350 load combinations, with the basis for loadings as defined herein:
  - 1. Load combinations for prestressed or post-tensioned items shall be in accordance with AWWA D110 and ACI 350.
  - 2. Load combinations for non-prestressed/post-tensioned items shall be in accordance with ACI 350.
  - 3. Snow load: See drawings for definitions of snow loads.
- D. Wind Loads (during construction and prior to backfilling):
  - 1. See drawings for definition of wind loads.
  - 2. Uniform live load over roof area: 20 psf. (non-reducible).

- E. Design and detail wall, foundation and roof per ACI 350 and AWWA D110.
- F. Design for lowest mean ambient temperature and for temperature differential required for project location.
- G. Roof:
  - 1. Conventionally reinforced construction: In accordance to ACI 350 relative to spacing between joints, minimum reinforcement ratios, and cracking serviceability (including serviceability load factors).
  - 2. Prestressed/post-tensioned construction: In accordance with AWWA D110 and ACI 350.
- H. Waterstops:
  - 1. Adhesive waterstops are not permitted.
  - 2. For sliding joints, deflection data shall be submitted and summarized from tank analysis for these locations.
  - 3. Shear, load and deflection capabilities for the proposed waterstop shall be certified in writing by waterstop manufacturer and shall be adequate for movement indicated in tank analysis.
  - 4. Continuous waterstops shall be used at all wall/footing and roof/wall joints. These joints shall be specifically detailed to remain watertight.

## **1.05 QUALIFICATIONS**

- A. Prestressing, Post-tensioning Supplier/Installer:
  - 1. In addition to qualifications listed in Section 33 16 40 – Water Storage Tanks:
    - a. Provide post-tensioning systems from a Post-Tensioning Institute (PTI) Certified Plant.
    - b. Erection engineer shall be a full-time employee of the pre-stressing and post-tensioning and wire-winding supplier/installer.

## **PART 2 PRODUCTS**

### **2.01 TANK**

- A. AWWA D110 Tank as manufactured by DN Tanks, Incorporated, 351 Cypress Lane, ElCajon, CA, 92020; The Crom Corporation, 250 SW 36<sup>th</sup> Ter, Gainesville, FL 32607, Preload, Incorporated, 49 Wireless Blvd #200, Hauppauge, NY 11788, Precon Tanks, 115 SW 140<sup>th</sup> Ter, Newberry, FL 32669, or equivalent with the following essential characteristics:
  - 1. Materials:
    - a. General requirements:
      - 1) Comply with AWWA D110, PTI TAB.1 and ACI 350.

- b. Concrete:
  - 1) Wall, interior columns, and roof: 28-day compressive strength not less than 4,500 pounds per square inch (psi) and shall be air entrained.
  - 2) Floor: 28-day compressive strength not less than 4,500 psi and no air entrainment.
  - 3) Superplasticizer and water reducing admixture shall be incorporated into floor concrete.
- c. Shotcrete:
  - 1) 28-day compressive strength not less than 4,500 psi.
  - 2) Cement: Conform to Section 03 30 00 – Cast-in-Place Concrete.
  - 3) Conform to ACI 506.2.
- 2. Prestress wire or strand for circumferential wrapping:
  - a. Cold drawn, high-carbon wire shall conform to ASTM A821, ASTM A227, ASTM A421, and ASTM A648 Class II, as applicable.
  - b. Strand shall conform to ASTM A416 or ASTM A475, as applicable.
  - c. Where tank surface is exposed to earth, weather, or liquid and less than 2-inches of concrete cover is provided, strand or wire shall be galvanized per requirements ASTM A586, Table 4, for Class A coating.
- 3. Reinforcing bars, wire mesh:
  - a. Reinforcing Bars: ASTM A615, Grade 60.
  - b. Wire Mesh: ASTM A185 or ASTM A497.
  - c. Conform to Section 03 20 00 – Concrete Reinforcing.
- 4. Wedges:
  - a. Wedge shall conform to PTI TAB.1. Wedge shall not break into separate pieces upon stressing.
  - b. Designed to securely anchor the strand without significantly reducing ductility of the strand or tendon.
  - c. Strand slip after anchoring shall not be permitted.
  - d. Prevent breaking of individual strand wires in the wedges during stressing.
  - e. Achieve dynamic fatigue and impact loading resistance without strand slippage or wire breakage.
- 5. Steel diaphragm (as applicable):
  - a. Provide vertically ribbed steel sheets with adjacent and opposing channels that provide mechanical bond to concrete.
  - b. Conform to ASTM A1008 or A653.

- c. Minimum thickness: ~~24~~26 gauge.
  - d. Uncoated sheet steel shall comply with ASTM A1008.
  - e. Galvanized sheet steel shall comply with ASTM A653 and have a ~~with a~~ minimum G90 coating per table 1 of ASTM A653.
6. Elastomeric materials:
    - a. Bearing pads conforming to ASTM D2240 or ASTM D2000.
    - b. Sponge filler conforming to ASTM D1056 or ASTM D1752.
    - c. Epoxy-ASTM C881 Type III, Grade I.
  7. Strand for earthquake cables:
    - a. Galvanized or epoxy coated with a fusion-bonded, grit-impregnated coating according to ASTM A882.
    - b. ASTM A416, Grade 250 or 270 before galvanizing, ASTM A586, ASTM A603, or ASTM A475 after galvanizing. Only hot-dipped galvanizing shall be permitted for zinc coating.
  8. Vertical/Roof/Floor prestressed reinforcement (as required):
    - a. Strand: ASTM A416, Grade 250 or 270.
    - b. Threadbar: ASTM A722, Grade 150 or 160.
    - c. Post-tensioning systems shall be produced by a PTI certified plant and tested to meet requirements of ACI 350 for corrosion protection.
    - d. Post-tensioning systems shall be fully encapsulated.
    - e. Prestressed reinforcing left in ducts for more than 10-days prior to grouting shall be corrosion-protected in accordance with AWWA D110.
  9. Ducts for bonded tendons:
    - a. Ducts for bonded tendons shall be manufactured from corrosion-resistant materials and shall comply with PTI Guide Specification, "Acceptance Standards for Post-tensioning Systems."
  10. Grout fitting:
    - a. Grout fittings shall conform to PTI M50.3.
    - b. Tendons shall have grout openings at stressing anchorages.
    - c. Provide grout vents or drain holes low and high points.
    - d. Prevent grout leakage at grout openings or vents.
  11. Grout materials: PTI M50.3 and AWWA D110.
  12. Couplings:
    - a. Couplings for bonded tendons shall not reduce the elongation of rupture below the requirements of the tendon itself.
    - b. Use where approved by erection engineer.

## **2.02 ACCESSORIES**

- A. Access Doors:
  - 1. Materials:
    - a. Aluminum.
    - b. Stainless steel or aluminum bolts.
- B. Interior Ladder:
  - 1. Type 304 stainless steel.
  - 2. Requirements for interior ladder: Comply with OSHA and Building Code.
  - 3. All supports on tank interior shall be stainless steel.
- C. Silt Stops:
  - 1. Provide removable silt stop(s) at all discharge pipes and at other locations shown.

## **PART 3 EXECUTION**

### **3.01 CONSTRUCTION**

- A. Comply with AWWA D110, ACI 372 and ACI 350.
- B. Do not place concrete floor and foundation until subgrade approved by erection engineer.
- C. Core Wall:
  - 1. Provide continuous and full-length steel diaphragm between tank contents and prestressing wires:
    - a. With no horizontal joints.
    - b. Mechanically seam vertical diaphragm joints except where located between wall panels, where either mechanical seaming or sealing with epoxy may be employed.
    - c. Seal all vertical diaphragm joints to be full watertight.
    - d. Piercing of the diaphragm is not permitted except by design.
    - e. Do not allow form ties pierce diaphragm.
  - 2. Fabricate precast panels to curvature of tank radius:
    - a. Tolerance in panel wall thickness: 0 to 1/4-inch.
    - b. Place concrete for each panel in one continuous operation.
  - 3. Locate bearing pads and hold them in position prior to erection of wall panels. Do not nail pads.

4. Properly secure sponge filler pads. Calk all voids around bearing pads and sponge with non-toxic sealant to prevent mortar seepage.
5. Field-placed concrete or shotcrete shall be form and/or water cured until prestressing begins.

D. Horizontal Prestressing:

1. The term “wire” shall signify either wire or strand.
2. Place prestressing wire on wall with a wire winding machine capable of consistently producing stress in the wire within a range of 0 percent to  $\pm 2$  percent of stress required by design:
  - a. No circumferential movement of the wire along tank wall will be permitted during or after stressing the wire.
3. Stressing may be accomplished by drawing the wire through a die or by other means that result in uninterrupted elongation, thus assuring uniform stress throughout its length and over periphery of tank.
4. Temporarily anchor each coil of prestressing wire at sufficient intervals to minimize the loss of prestress in case a wire breaks during wrapping.
5. Minimum spacing (center to center) of prestressing wires is 3/8-inch and a minimum clear space between wires of 5/16-inch or 1.5 wire diameters, whichever is greater:
  - a. Respace any wires not meeting spacing requirements.
  - b. Do not place prestressing closer than 3-inches from base of walls or floors where radial movement may occur.
6. Displace band of prestressing normally required over height of an opening into circumferential bands immediately above and below opening to maintain required prestressing force. Bundling of wires is prohibited.
7. Splicing of the wire shall be only permitted when completing the application of a full coil of wire, or when removing a defective section of wire:
  - a. Join ends of individual coils by suitable steel splicing devices capable of developing the full strength of the wire.
8. Use a calibrated stress recording device, which can be recalibrated, in determining wire stress levels on the wall during and after the prestressing process.

E. Take at least one stress reading per foot or one stress reading for every roll of wire, whichever is greater, immediately after the wire has been applied on the wall:

1. Record readings referring to the applicable height and layer of wire for which the stress is being taken.
2. Contractor to keep a written record of stress readings and then deliver said record to COR.
3. Make stress readings on straight lengths of wire.

4. If applied stresses fall below design stress in the steel, provide additional wire to bring stress up to required design stress.
5. If stress in the steel is more than 7 percent over required design stress, wrapping operation should be discontinued and adjusted.

F. Floor:

1. No construction joints are permitted.
2. Minimum thickness of 8-inches of concrete required over all pipe encasements in concrete floor (if applicable).
3. Reference Section 31 23 10 – Earthwork for subgrade conditions
4. Actively reinforced (structural) floors shall be a minimum 8-inches thick:
  - a. Apply not less than minimum percentage of reinforcing steel to these thickened sections and extend a minimum of 2-feet into adjacent floor.
5. Consolidate floor slab so no air pockets or voids are present.

G. Shotcrete:

1. Weather limitations: Comply with AWWA D110.
2. Placement: Comply with ACI 506.2 and AWWA D110.
3. All shotcrete shall be applied by ACI certified nozzlemen.
4. Vertical screed wires shall be used to ensure uniform and correct thickness of shotcrete.
5. Test wall for hollow spots and repair any defective areas.
6. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding for subsequent layer.
7. Do not apply shotcrete to reinforcing steel or diaphragm which is encrusted with overspray.
8. Coating of steel diaphragm:
  - a. Cover steel diaphragm with a layer of shotcrete at least 1-inch thick prior to prestressing.
  - b. Total minimum coating over steel diaphragm: 3-inches including diaphragm cover, wire cover and finish covercoat.
9. Coating over prestressing wire:
  - a. Individually encase each prestressed wire in shotcrete of thickness sufficient to provide clear cover over the wire of at least 1/2-inch.
  - b. Apply finish coat of shotcrete as soon as practicable after last application of wire coat:
    - 1) Total thickness of shotcrete covercoat: Not less than 2-inches over wire or strand.
  - c. Provide natural gun finish.

H. Tolerances:

1. Out-of-plumb in total wall height:  $\pm 1/2$ -inch.
2. Out-of-round in diameter:  $\pm 1$ -inch.

I. Roof:

1. Cast-in-place or precast concrete free spanning dome roof:
  - a. Dome roof shall have a rise to span ratio within the range of 1:8 to 1:14.
  - b. Minimum concrete thickness shall be 5-inches for both a precast dome and cast-in-place dome with a minimum 1 1/2-inches of cover to any reinforcement.
  - c. For a cast-in-place dome:
    - 1) Do not remove any portion of formwork for roof until the concrete is of sufficient strength. Refer to ACI 350.
    - 2) Give roof soffit a form finish. Give exterior roof surface a floated finish.
  - d. Dome shall be fixed to tank wall.
  - e. Columns or interior supports will not be permitted.
  - f. Dome designs shall be based on elastic spherical shell analysis.
2. Cast-in-place prestressed/post-tensioned concrete roof:
  - a. No construction joints are permitted.
  - b. Construct roof to be supported by perimeter walls and interior columns:
    - 1) Locate and design interior columns and roof system to result in adequate strength and to limit deflections in accordance with ACI 350 and IBC as applicable.
    - 2) Minimum slope at top surface: 1.5 percent center to edge.
  - c. Do not remove any portion of formwork for roof until concrete is of sufficient strength and tendons have been fully tensioned (as applicable). Refer to ACI 350.
  - d. Give roof soffit a form finish. Give exterior roof surface a floated finish.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

A. Test concrete in accordance with ACI 350.

B. Shotcrete:

1. Test in accordance with ACI 506.2.
2. Make tests from shotcrete as it is being placed.
3. Sounding of shotcrete covercoat as recommended in AWWA D110.

C. Watertightness Testing:

1. Tank supplier shall perform watertightness testing.
2. Upon completion of tank, Supplier shall perform watertightness testing of tank:
  - a. Watertightness testing shall be performed prior to application of water proofing, if applicable, to tank walls.
  - b. Water for watertightness testing shall be supplied by Contractor.
  - c. Level for watertightness testing shall be high water level as shown on drawings.
  - d. Procedures and criteria for watertightness testing and acceptance shall be as defined in ACI 350.1. Maximum allowable loss shall be 0.0125 percent of tank volume per day.

**END OF SECTION**

**SECTION 33 16 52**  
**CONCRETE PRESTRESSED TANK**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Cost: In accordance with Section 33 16 40 – Water Storage Tanks.

**1.02 REFERENCE STANDARDS**

A. America Concrete Institute (ACI)

- |    |              |   |
|----|--------------|---|
| 1. | ACI 350-06   | Building Code Requirements for Environmental Engineering Concrete Structures                  |
| 2. | ACI 350.1-10 | Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary |
| 3. | ACI 350.3-06 | Seismic Design of Liquid-Containing Concrete Structures and Commentary                        |

B. ASTM International (ASTM)

- |    |                        |  |
|----|------------------------|--|
| 1. | ASTM A185 / A185M – 07 | Steel Welded Wire Reinforcement, Plain, for Concrete   |
| 2. | ASTM A416/A416M - 12a  | Steel Strand, Uncoated Seven-Wire for Prestressed Concrete   |
| 3. | ASTM A497/A497M - 07   | Steel Welded Wire Reinforcement, Deformed, for Concrete  |
| 4. | ASTM A615/A615M - 12   | Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement  |
| 5. | ASTM A722/A722M - 12   | Uncoated High-Strength Steel Bars for Prestressing Concrete  |
| 6. | ASTM C881/C881M - 10   | Epoxy-Resin-Base Bonding Systems for Concrete  |
| 7. | ASTM D1056 - 07        | Flexible Cellular Materials - Sponge or Expanded Rubber.   |
| 8. | ASTM D1752 - 04a(2008) | Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |

- |  |                       |  |
|--|-----------------------|--|
| 9.   | ASTM D2000 - 12       | Standard Classification System for Rubber Products in Automotive Applications              |
| 10.  | ASTM D2240 - 05(2010) | Standard Test Method for Rubber Property - Durometer Hardness                              |
| C. American Water Works Association (AWWA) |                       |  |
| 1.   | AWWA C 652-02         | Disinfection of Water Storage Facilities.  |
| 2.   | AWWA D 115-06         | Tendon-Prestressed Concrete Water Tanks  |
| D. American Welding Society (AWS)          |                       |  |
| 1.   | AWS D1.1/D1.1M 10     | Structural Welding Code, Steel   |
| 2.   | AWS D1.3/D1.3M-08     | Structural Welding Code, Sheet Metal   |
| E. International Building Code (IBC)       |                       |  |
| 1.   | IBC 2009              | International Building Code (IBC)  |
| F. Post Tensioning Institute (PTI)         |                       |  |
| 1.   | PTI DC10.7-83         | Post-Tensioned Commercial and Industrial Floors  |
| 2.   | PTI TAB.1-06          | Post-Tensioning Manual, Sixth Edition  |
| 3.   | PTI DC20.8-04         | Design of Post-Tensioned Slabs Using Unbonded Tendons                                      |
| 4.   | PTI M10.2-00          | Specification for Unbonded Single Strand Tendons   |
| 5.   | PTI M10.3-00          | Field Procedures Manual for Unbonded Single Strand Tendons                                 |
| 6.   | PTI M50.3-12          | Specification for Grouting of Post-Tensioned Structures                                    |
| 7.   | PTI CRT20             | Manual for Certification of Plants Producing Unbonded Single Strand Tendons, Sixth Edition |

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 33 16 52-1, Approval Drawings and Data:
1. Shop drawings:
    - a. Show all details that shall be used in the fabrication of tank components and tank construction.

2. Manufacturer's installation instructions.
  3. Tank surface finishes and coating materials.
  4. Waterstop product information, samples, and certifications as requested by Contract Documents.
  5. Concrete design mixes.
  6. Structural design calculations or analyses sealed by a professional engineer registered in the State of New Mexico, for record purposes only.
- C. RSN 33 16 52-2, Test Reports:
1. Submit certified mill test reports indicating ultimate and yield strength of all reinforcing bars, prestressing and post-tensioning steel, and any other steel components.
- D. RSN 33 16 52-3, Documentation:
1. Furnish applicable "Affidavits of Compliance" to building codes.
- E. RSN 33 16 52-4, Final Drawings and Data:
1. Submit final drawings and data consisting of approved detailed shop drawings.
  2. Submit Operation and Maintenance Manuals.

#### **1.04 DESIGN REQUIREMENTS**

- A. Tank:
1. Refer to Section 33 16 40 – Water Storage Tanks.
  2. Design in conformance with ACI 350, and AWWA D115 and PTITAB.1:
    - a. Cast-in-Place Concrete with internal tendons.
  3. Design floor and roof for single concrete placements, no joints are allowed.
  4. Floor design shall take into account concentrated loads from roof column supports.
  5. Tank foundation drain to be installed under tank floor. See Drawing 1695-D-60442 and 1695-D-60443.
  6. Perimeter wall shall be horizontally and vertically prestressed and cast in full-height placements:
    - a. Refer to 33 16 40 – Water Storage Tanks for concrete thickness.
    - b. Thickness of concrete wall shall be as required by AWWA D115, and applied loading, but shall not be less than 9-inches.
    - c. Backfill loads shall not be used in design of the tank to counteract hydraulic loads or provide residual compression in the wall.

- d. Tank analysis and design shall take into account all required openings and penetrations through tank elements.
  - e. Slope of floor: 1 percent center to edge.
- B. Design for earthquake resistance based on ACI 350.3 and the requirements of AWWA D115.
- C. Base design on AWWA D115 and ACI 350 load combinations, with basis for loadings as defined herein:
  - 1. Load combinations for prestressed or post-tensioned items shall be in accordance with AWWA D115 and ACI 350.
  - 2. Load combinations for non-prestressed/post-tensioned items shall be in accordance with ACI 350.
  - 3. Snow load: See drawings for definitions of snow loads.
  - 4. Uniform live load over roof area: 20 psf. (non-reducible).
- D. Wind Loads (during construction and prior to backfilling):
  - 1. See drawings for definition of wind loads.
- E. Design for lowest mean ambient temperature and for temperature differential required for project location.
- F. Roof Design Criteria:
  - 1. Roof design for conventionally reinforced construction shall be in accordance with ACI 350 relative to spacing between joints, minimum reinforcement ratios, and cracking serviceability (including serviceability load factors).
  - 2. Roof design for prestressed/post-tensioned construction shall be in accordance with AWWA D115 and ACI 350.
- G. Waterstops:
  - 1. Adhesive waterstops are not permitted.
  - 2. For sliding joints, deflection data shall be submitted and summarized from tank analysis for these locations.
  - 3. Shear, load and deflection capabilities for the proposed waterstop shall be certified in writing by waterstop manufacturer and shall be adequate for movement indicated in tank analysis.
  - 4. Continuous waterstops shall be used at all wall/footing and roof/wall joints. Joints shall be specifically detailed to remain watertight.

## **1.05 QUALIFICATIONS**

- A. In addition to qualifications listed in Section 33 16 40 – Water Storage Tanks:

1. Post-tensioning components and systems shall be provided by PTI CRT20-Certified Plant.

2. Superintendent shall be full-time employee of post tensioning supplier and shall be present during construction of tank:
  - a. Superintendent shall be holder of current Certified Grouting Technician certificate from American Segmental Bridge Institute.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

#### **A. General Requirements:**

1. Comply with AWWA D115, ACI 350, PTI TAB.1.

#### **B. Concrete:**

1. Wall, interior columns, and roof: 28-day compressive strength not less than 4,500 pounds per square inch (psi) and shall be air entrained.
2. Floor: 28-day compressive strength not less than 4,500 psi and no air entrainment.
3. Incorporate superplasticizer and water reducing admixture into floor concrete.

#### **C. Prestress Strand for Circumferential Tendons:**

1. Comply with ACI 350.
2. Strand shall conform to ASTM A416, ASTM A722, or ASTM A582.

#### **D. Reinforcing Bars, Wire Mesh:**

1. Reinforcing Bars: ASTM A615, Grade 60.
2. Wire Mesh: ASTM A185 or ASTM A497.

#### **E. Wedges:**

1. Wedge shall conform to PTI TAB.1. Wedge shall not break into separate pieces upon stressing.
2. Designed to securely anchor strand without significantly reducing ductility of strand or tendon.
3. Strand slip after anchoring shall not be permitted.
4. Prevent breaking of individual strand wires in wedges during stressing.
5. Achieve dynamic fatigue and impact loading resistance without strand slippage or wire breakage.

#### **F. Elastomeric Materials:**

1. Bearing pads: ASTM D2240 or ASTM D2000.
2. Sponge filler: ASTM D1056 or ASTM D1752.

3. Epoxy: ASTM C881 Type III, Grade I.
- G. Vertical/Roof Prestressed Reinforcement (as required):
1. Strand: ASTM A416, Grade 250 or 270.
  2. Threadbar: ASTM A722, Grade 150 or 160.
  3. Corrosion protect vertical prestressed reinforcing left in ducts for more than 21-days prior to grouting in accordance with AWWA D115.
- H. Ducts for Bonded Tendons:
1. Ducts for bonded tendons shall be manufactured from corrosion-resistant materials and shall comply with PTI Guide Specification, "Acceptance Standards for Post-tensioning Systems."
- I. Grout Fitting:
1. Grout fittings shall conform to PTI M50.3.
  2. Tendons shall have grout openings at stressing anchorages.
  3. Provide grout vents or drain holes low and high points.
  4. Prevent grout leakage at grout openings or vents.
- J. Grout Materials: PTI M50.3 and AWWA D115.
- K. Couplings:
1. Couplings for bonded tendons shall not reduce the elongation of rupture below requirements of the tendon itself.
  2. Used where approved by Erection Engineer.
- L. Silt Stops:
1. Provide removable silt stop(s) at all discharge pipes and at other locations shown.

## **PART 3 EXECUTION**

### **3.01 CONSTRUCTION**

- A. General:
1. In accordance with AWWA D115.
  2. Do not place concrete floor and foundation until subgrade approved by Erection Engineer.
  3. For wall base joints with bearing pads, locate bearing pads and hold them in proper position prior to erection of wall panels. Do not nail pads. Properly secure sponge filler pads. Calk all voids around bearing pads and sponge with a non-toxic sealant to prevent mortar seepage.

4. Field-placed concrete floors and roofs shall be form and/or water cured until prestressing begins.
- B. Floor:
1. No construction joints are permitted.
  2. Minimum thickness of 8-inch of concrete required over all pipe encasements in concrete floor (if applicable).
  3. Actively reinforced (structural) floors shall be minimum 8-inches thick.
  4. Use at least minimum percentage of reinforcing steel to these thickened sections and extend a minimum of 2-feet into adjacent floor.
- C. Refer ACI 350 for curing, hot and cold weather concreting, forming and troweled finish.
- D. Consolidate floor slab so no air pockets or voids are present.
- E. Tolerances:
1. Out-of-plumb in total wall height:  $\pm 1/2$ -inch.
  2. Out-of-round in diameter:  $\pm 1$ -inch.
- F. Roof:
1. Support roof by perimeter walls and interior columns:
    - a. No construction joints are permitted
    - b. Locate and design interior columns and roof system to result in adequate strength and to limit deflections in accordance with ACI 350 and IBC as applicable.
    - c. Minimum slope at top surface: 1 percent center to edge.
    - d. Design forms to resist all forces acting, including forces with respect to sloped surfaces.
  2. Do not remove any portion of formwork for roof until concrete is of sufficient strength and tendons have been fully tensioned (as applicable).
  3. Give roof soffit a form finish. Give exterior roof surface a floated finish.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Test concrete in accordance with ACI 350.
- B. Watertightness Testing:
1. Tank supplier shall perform watertightness testing.
  2. Upon completion of tank, tank supplier shall perform leak testing of tank:

- a. Watertightness testing shall be performed prior to application of water proofing, if applicable, to tank walls.
- b. Water for watertightness testing shall be supplied by Contractor.
- c. Level for watertightness testing shall be high water level as shown on drawings.
- d. Procedures and criteria for watertightness testing and acceptance shall be as defined in ACI 350.1. Maximum allowable loss shall be 0.0125 percent of tank volume per day.

**END OF SECTION**

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**SECTION 33 42 30**  
**CORRUGATED METAL PIPE CULVERT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. 36-Inch Diameter Corrugated Metal Pipe Culvert:
1. Measurement: Length along pipe centerline at pipe invert:
    - a. From end to end of pipe in place.
    - b. No allowance for coupling bands and lap at joints.
  2. Payment: Linear foot price offered in Price Schedule 1 (Pumping Plant No. 4):
    - a. Includes flared end sections and earthwork.

**1.02 REFERENCE STANDARDS**

- A. ASTM International (ASTM)
1. ASTM A760/A760M - 10 Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
  2. ASTM A849 - 15 Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe

**1.03 DELIVERY, STORAGE, AND HANDLING**

- A. Haul and handle pipe to avoid damage to galvanized coating.
- B. Do not use rope, cable, or chain slings for handling pipe.

**PART 2 PRODUCTS**

**2.01 CORRUGATED METAL PIPE**

- A. Corrugations:
1. 2 2/3- by 1/2-inch unless otherwise indicated on drawings or in schedule.
  2. Annular or helical.
- B. Sheet thickness: 0.064-inch.
- C. Corrugated Steel Pipe, and Coupling Bands:
1. ASTM A760, Type I.

2. Galvanized.
  3. ASTM A849.
- D. Flared End Sections:
1. Prefabricated sections of standard manufacture.
  2. Same metal as pipe to which attached.

## **2.02 BACKFILL**

- A. Insofar as practicable, obtain backfill material from material moved in required excavations for pipe or from adjacent excavation. Type of material used for backfill is subject to approval.
- B. Maximum Particle Size:
1. Backfill within 1-foot of pipe: 1 1/2-inches.
  2. Compacted backfill in trench: 3-inches.
  3. Uncompacted backfill in pipe trench: 3-inches.

## **PART 3 EXECUTION**

### **3.01 CORRUGATED METAL PIPE**

- A. Furnish and lay corrugated metal pipe of size and gauge shown on drawings complete with coupling bands and joint materials.
- B. Install flared end section on inlet and outlet end of each pipe.

### **3.02 EXCAVATION**

- A. Excavation for pipe trench: In accordance with Section 31 23 22 – Pipe Trench Earthwork.

### **3.03 LAYING CORRUGATED METAL PIPE**

- A. Lay corrugated metal pipe to lines and grades shown on drawings or established by CO:
1. Laying tolerances:
    - a. Departure from and return to established alignment and grade, maximum: 1/8-inch per foot of pipe.
    - b. Total departure, maximum: 1-inch.
- B. Place pipe carefully to be fully supported over bottom quarter of circumference.
- C. Lay pipe with outside laps of circumferential joints pointing upstream and with longitudinal joints at the sides.

- D. Coupling Bands:
  - 1. Use where necessary to join sections of pipe.
  - 2. Draw fastenings up tight.
  - 3. Install to ensure tight joints.
  - 4. Joints between sections approximately at center of couplings.
- E. Install flared end sections in accordance with manufacturer's instructions.

### **3.04 BACKFILL**

- A. As each unit of pipe is laid, tamp backfill material about pipe to hold it rigidly in place until joints are completed.
- B. After joints have been completed, place and compact backfill or CLSM in accordance with Sections 31 23 22 – Pipe Trench Earthwork and 31 23 70 – Controlled Low Strength Materials (CLSM).
- C. Equipment travel over the pipe not permitted until backfill has been placed and compacted to depth recommended by pipe manufacturer, but not less than 3-feet above top of pipe. Provide adequate earth cover over pipe to prevent damage from construction equipment loads.

### **3.05 REPAIR**

- A. Repair damage to galvanized coatings including factory or field cut edges and welding in accordance with ASTM A760.

**END OF SECTION**

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**SECTION 35 21 95**  
**STEEL MANIFOLD PIPING**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Steel Manifold Piping:

1. Payment: Lump sum prices offered in the Price Schedules.

**1.02 DEFINITIONS**

A. Steel Manifold Piping:

1. Details of steel manifolds and water quality sampling piping are shown on drawings 1695-D-60595 through 1695-D-60624 and 1695-D-60389 through 1695-D-60395.

**1.03 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

- |    |                 |   |
|----|-----------------|---|
| 1. | ANSI/NSF 61-17  | Drinking Water System Components – Health Effects |
| 2. | ANSI/NSF 372-16 | Drinking Water System Components – Lead Content   |

B. American Society of Mechanical Engineers (ASME)

- |    |                       |   |
|----|-----------------------|---|
| 1. | ASME B1.20.1-2013     | Pipe Threads, General Purpose (Inch)  |
| 2. | ASME B16.5-2017       | Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24  |
| 3. | ASME B16.9-2012       | Factory Made Wrought Buttwelding Fittings   |
| 4. | ASME B16.11-2016      | Forged Fittings, Socket-Welding and Threaded  |
| 5. | ASME B16.15-2018      | Cast Copper Alloy Threaded Fittings Classes 125 and 250   |
| 6. | ASME B16.21-2016      | Nonmetallic Flat Gaskets for Pipe Flanges   |
| 7. | ASME B31.1-2018       | Power Piping  |
| 8. | ASME BPVC.VIII.1-2017 | Boiler and Pressure Vessel Code, Section VIII, Division 1, Rules for Construction of Pressure Vessels |
| 9. | ASME PCC-1-2013       | Guidelines for Pressure Boundary Bolted Flange Joint Assembly   |

- C. ASTM International (ASTM)
1. ASTM A36/A36M-14 Carbon Structural Steel
  2. ASTM A53/A53M-18 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
  3. ASTM A105/A105M-14 Carbon Steel Forgings for Piping Applications
  4. ASTM A139/A139M-16 Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
  5. ASTM A182/A182M-18 Forged or Rolled Alloy and Stainless- Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
  6. ASTM A193/A193M-17 Alloy-Steel and Stainless- Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
  7. ASTM A194/A194M-17a Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
  8. ASTM A234/A234M-18 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
  9. ASTM A240/A240M-17 Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  10. ASTM A312/A312M-17 Seamless, Welded, and Heavily Cold Worked Austenitic Stainless-Steel Pipes
  11. ASTM A403/A403M-18 Wrought Austenitic Stainless-Steel Piping Fittings
  12. ASTM A420/A420M-16 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low Temperature Service
  13. ASTM A500/A500M-18 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  14. ASTM A588/A588M-15 High-Strength Low-Alloy Structural Steel, up to 50 ksi Minimum Yield Point, with Atmospheric Corrosion Resistance
  15. ASTM A572/A572M-18 High-Strength Low-Alloy Columbium-Vanadium Structural Steel
  16. ASTM A1011/A1011M-18 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

- |  |                      |   |
|--|----------------------|---|
| 17.  | ASTM A1018/A1018M-18 | Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| 18.  | ASTM D1785-15e1      | Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120  |
| 19.  | ASTM D2467-15        | Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80   |
| 20.  | ASTM D2564-12        | Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems   |
| 21.  | ASTM D2855-15        | Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets                          |
| 22.  | ASTM D4020-11        | Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials  |
| 23.  | ASTM E165/E165M-12   | Liquid Penetrant Examination for General Industry   |
| D. American Welding Society (AWS)          |                      |   |
| 1.   | AWS D1.1/D1.1M:2015  | Structural Welding Code - Steel   |
| E. American Water Works Association (AWWA) |                      |   |
| 1.   | AWWA C200-17         | Steel Water Pipe - 6 In (150 mm) and Larger   |
| 2.   | AWWA C206-17         | Field Welding of Steel Water Pipe   |
| 3.   | AWWA C207-18         | Steel Pipe Flanges for Waterworks Service, Sizes 4 In. through 144 In. (100 mm Through 3,600 mm)  |
| 4.   | AWWA C208-17         | Dimensions for Fabricated Steel Water Pipe Fittings   |
| 5.   | AWWA C219-17         | Bolted Sleeve-Type Couplings for Plain-End Pipe   |
| 6.   | AWWA C220-17         | Stainless-Steel Pipe 1/2 In. (13 mm) and Larger   |
| 7.   | AWWA C227-17         | Bolted, Split-Sleeve Couplings  |

- |     |              |  |
|-----|--------------|--|
| 8.  | AWWA C228-14 | Stainless-Steel Flanges for Water Service –<br>Sizes 2 In. through 72 In (50 mm through<br>1,800 mm) |
| 9.  | AWWA C604-17 | Installation of Buried Steel Water Pipe –<br>4 In. (100 mm) and Larger                               |
| 10. | AWWA C606-15 | Grooved and Shouldered Joints  |
- F. Commercial Item Descriptions (CID)
- |    |                  |   |
|----|------------------|---|
| 1. | CID-A-A-1923A-01 | Shield Expansion (Lag, Machine and<br>Externally Threaded Wedge Bolt Anchors) |
|----|------------------|---|
- G. Hydraulic Institute (HI):
- |    |               |   |
|----|---------------|---|
| 1. | HI 9.6.2-2015 | Rotodynamic Pumps for Assessment of<br>Applied Nozzle Loads |
|----|---------------|---|

#### **1.04 REFERENCE SPECIFICATIONS**

- A. 01 33 00 – Submittals.
- B. 01 78 30 – Cleaning and Waste Management.
- C. 31 23 22 – Pipe Trench Earthwork.

#### **1.05 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 35 21 95-1, Shop Drawings:
  - 1. Checked, detailed shop drawings including dimensions and tolerances, material data, joint details, and welding requirements:
    - a. Provide checked box on each drawing indicating date drawing was checked and by whom.
    - b. Drawings of Contractor designed fixed pipe supports including anchoring:
      - 1) General assembly drawings, subassembly drawings, details and field joints.
      - 2) Anchorage including embed depth and other pertinent details.
      - 3) Stamped and signed by registered Structural professional engineer in State of New Mexico.
- C. RSN 35 21 95-2, Hydraulic Thrust Analysis:
  - 1. Perform complete analysis of hydraulic forces and operational loads acting on piping from pump nozzle through 16-inch pump discharge pipe to and including 42-inch main discharge pipe. Perform analysis for each of the following conditions:

- a. Pump start up and pump shut down.
  - b. Normal operating conditions.
  - c. Hydraulic transient events.
    - 1) Include the weight of equipment and water.
    - 2) Include misalignment and vibration.
    - 3) Include forces due to seismic events. See drawing 1695-D-60399 for seismic site information.
2. Design and provide fabricated steel fixed pipe supports on 42-inch main discharge pipe:
- a. Submit design data and structural calculations for fixed pipe supports including associated anchoring:
    - 1) Consider forces on fixed pipe supports to be completely unbalanced and to be the full thrust due to hydraulic pressures in the hydraulic scenarios in 1.05 C 1.
  - b. Provide loading diagrams of loads transferred from fixed pipe support valve to anchorage and to concrete floor.
  - c. Fixed supports to resist all forces acting upon them such that the support pipe is attached to will not move.
  - d. Allowable stresses of 1/2 of material yield stress are not to be exceeded in fixed pipe supports, 16-inch and 42-inch discharge pipes.
  - e. Material: Steel plate and other steel materials specified herein.
  - f. Fixed pipe support is to be anchored to concrete floor with steel threaded rods, nuts and washers.
  - g. Locate fixed pipe supports as shown on drawings. Alternative locations may be considered, subject to Government approval.
3. Calculations clearly showing pump nozzle forces do not exceed allowable pump nozzle forces in HI 9.6.2:
- a. Perform analysis based on specifications Sections and drawings, Contractor designed fixed pipe supports and the hydraulic scenarios in 1.05 C 1.
4. Design calculations and analysis:
- a. All drawings and calculations stamped and signed by registered Structural professional engineer in State of New Mexico.
  - b. Reference source of each calculation in a standard or textbook.
  - c. Provide drawings, sketches or other data as needed to clarify forces or other items being calculated.
  - d. Engineering data and catalog cut sheets.

D. RSN 35 21 95-3, Commercial Products Data:

1. Pipe couplings:
  - a. Include manufacturer certification for the 450 psi working pressure 16-inch coupling at pump discharge harnessed joint.
2. Dismantling joints.
  - a. Manufacturer shall submit a written statement that the inspection and all specified tests have been completed and that results comply with the requirements AWWA C219.
3. Gaskets.
4. Air vent damper.

E. RSN 35 21 95-4, Pipe Installation Procedure and Calculations:

1. Structural calculations and details of supports and tiedowns for the steel manifold piping stamped and signed by a registered professional engineer in State of New Mexico:
  - a. Calculations must demonstrate that the tiedown system is adequate to resist uplift forces resulting from floatation of the steel manifold piping in freshly placed concrete and that the tiedown system will not cause stresses in excess of the allowable in the steel manifold piping.
2. Methods for maintaining circularity and preventing damage to steel pipe, fittings, lining and coating during loading, transporting, unloading, storing, and laying.
3. Type and location of pipe supports and tie downs to be used.
4. Methods for ensuring pipe alignment.
5. Type, locations, and details of field welds.
6. Installation procedure.

F. RSN 35 21 95-5, Field Weld Test Results:

1. Results of air and soap tests on field welded double lap and butt strap joints.

G. RSN 35 21 95-6, Final Drawings:

1. Complete set of As-Built drawings
  - a. Clearly mark drawings 1695-D-60595 through 1695-D-60624 and 1695-D-60389 through 1695-D-60395 to show all field modifications of the final installation.
  - b. Submit drawings in accordance with Section 01 33 00 – Submittals article 1.04 paragraph C.6 and Section 01 78 30 – Cleaning and Waste Management.

## **1.06 QUALIFICATIONS**

- A. Stainless-steel pipe welders: Welders and Welding Operators to be qualified in accordance with ASME BPVC Section IX.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. During loading, transporting, unloading, storing, and laying, prevent damage to steel manifold piping linings and coating. Transport and handle in accordance with fabricator's instructions:
  - 1. Provide padded bolsters curved to fit under outside of pipe.
  - 2. Provide heavy padding under ties during transportation and storage.
- B. Maintain circularity of pipe sections during coating, lining, transporting, and installing operations:
  - 1. Provide stulls or adjustable spiders.
  - 2. Measured deviation between maximum and minimum diameters at stulls or spiders shall not exceed 0.5 percent of nominal pipe diameter.
- C. Do not store directly on the ground.
- D. Store so that lifting straps can be passed beneath pipe sections.
- E. Provide space to allow personnel to move between pipe sections.
- F. Cover with tarps and tie down securely.
- G. Repair damage to lining and coating as directed if, in the opinion of COR, a satisfactory repair can be made; otherwise, replace damaged section at the expense of the Contractor and in accordance with Section 09 96 20 – Coatings.

## **PART 2 PRODUCTS**

### **2.01 EQUIPMENT**

- A. Piping and equipment materials:
  - 1. ANSI/NSF 372 certified lead-free.
  - 2. Suitable for potable water.
  - 3. Materials suitable for free chlorine residual exposure:
    - a. Typical free chlorine residual concentration: Maximum 4 milligrams per liter (mg/l).

- B. Steel plate:
1. ASTM A36, ASTM A1011, SS, Grade 36, 40, or 45; or ASTM A1018, SS, Grade 36 or 40.
- C. Steel tubing:
1. ASTM A500, Grades B or C.
- D. Standard and schedule steel pipe:
1. ASTM A53, Type E or S, Grade B:
    - a. Pipe 4-inches in diameter and smaller: Galvanized.
    - b. Pipe larger than 4-inches in diameter: In accordance with Section 09 96 20 – Coatings.
- E. Electric–fusion– (arc–) welded, spiral–seam steel pipe:
1. ASTM A139, Grade C, D, or E.
- F. Stainless-steel pipe:
1. AWWA C220 and ASTM A312, Type 304L or Type 316L.
  2. Hydrostatically test pipe in accordance with ASTM A312.
- G. Plastic pipe: Polyvinyl chloride (PVC) ASTM D1785.
- H. Stainless-steel plate:
1. ASTM A240, Type 304 or 316
  2. Orifice plates.
- I. Flanges:
1. Steel: Slip-on ring type, flat faced, AWWA C207 or ASME B16.5.
  2. Stainless-steel: Slip-on ring type, flat faced, AWWA C228, ASTM A182 or A240, Type 304L or Type 316L.
  3. Raised face: ASME B16.5, as shown on drawings.
  4. Flat face or raised face with finish suitable for gasket:
    - a. Provide spiral or concentric serrated grooved flange face gasket surface finishes that are suitable for the flat gasket material provided and for the operating pressures.
- J. Gaskets:
1. Suitable for cold potable water.
  2. Use Multi-Swell Style 3760-U manufactured by Garlock, [www.garlock.com](http://www.garlock.com); or equal, having the following essential characteristics:

- a. Dimensional requirements of AWWA C207 or ASME B16.5 as shown on drawings.
  - b. Flat, full face or ring type.
  - c. Minimum 500 psi cold water pressure rating.
  - d. ANSI/NSF 61 listed
  - e. Minimum 1/16-inch thick.
3. Use Gylon Style 3505, manufactured by Garlock [www.garlock.com](http://www.garlock.com); or equal, having the following essential characteristics:
    - a. For ASME B16.5 Class 300 raised face flanges.
    - b. Nonmetallic ring type for raised face flanges.
    - c. Minimum 675 psi cold water pressure rating.
    - d. ANSI/NSF 61 listed.
    - e. Suitable for cold water service.
    - f. Minimum 1/16-inch thick.
- K. Flange bolts:
1. AWWA C207 for AWWA flanges.
  2. ASME B16.5 for ASME flanges.
- L. Flange Support, may be required for control valves with square bottomed flanges:
1. Standon Model S89 manufactured by Standon Pipe Supports Inc., [www.standon.net](http://www.standon.net), Adjustable Pipe Supports – Flange Style manufactured by Trumbull Industries Inc., [www.trumbull-mfg.com](http://www.trumbull-mfg.com), or equal, having the following essential characteristics:
    - a. Adjustable height.
    - b. Material: Galvanized steel.
    - c. Suitable for flange connection as shown on drawings.
- M. Joint Harness:
1. Rings and gussets: ASTM A36 or ASTM A572, Grade 42.
  2. Tie rods: ASTM A193, Grade B7.
  3. Hex nuts: ASTM A194, Grade 2H.
- N. Threaded steel fittings:
1. ASME B16.11 and ASTM A105.
  2. Threaded NPT: ASME B1.20.1.

- O. Threaded Stainless-Steel Fittings:
1. ASME B16.11 and ASTM A182, Type 304 or 316.
  2. Threaded NPT: ASME B1.20.1.
- P. Threaded Bronze and Copper Alloy Fittings:
1. ASME B16.15 Class 250.
  2. Threaded NPT: ASME B1.20.1.
- Q. Butt-welding steel fittings:
1. ASME B16.9 and ASTM A234 or ASTM A420 - WPL6.
- R. Butt-welding stainless-steel fittings:
1. ASME B16.9 and ASTM A403, Type 304L or Type 316L.
- S. Socket-welding stainless-steel fittings:
1. ASME B16.11 and ASTM A182, Type 304L or 316L.
- T. PVC plastic pipe fittings: ASTM D2467.
- U. Steel Pipe Reducers: Designed, fabricated and dimensioned in accordance with AWWA C208.
- V. Restrained Dismantling Joints:
1. Model DJ400 AWWA CLS F manufactured by Romac Industries, [www.romac.com](http://www.romac.com), Baker Dismantling Joint manufactured by Baker Coupling Co., [www.bakercoupling.com](http://www.bakercoupling.com); or equal, having the following essential characteristics:
    - a. Minimum cold water working pressure rating: 300 psi.
    - b. Flanges: AWWA C207, Class F.
    - c. Outer body and inner body shall be in accordance with AWWA C200.
    - d. End ring: AWWA C219
    - e. Gaskets: AWWA C219.
    - f. Bolts and nuts: ASTM A588 HSLA bolt material.
    - g. Tie-Rods: High tensile steel per ASTM A193 Grade B7.
    - h. Pressure rating: Equal to maximum rating of adjacent flange.
    - i. Assembly tolerance: Three inches flange face to flange face.
    - j. Hydrostatically test the dismantling joint in accordance with AWWA C219.

- k. Manufacturer shall submit a written statement that inspection and all specified tests have been completed and that results comply with AWWA C219 requirements.
- l. Components in contact with potable water shall be certified to comply with NSF/ANSI 61, and a copy of NSF/ANSI 61 certification shall be provided to Government, if requested.

W. Pipe couplings:

1. Steel:

- a. Grooved-end: Style 77 or Style W77 manufactured by Victaulic, [www.victaulic.com](http://www.victaulic.com); or equal, having the following essential characteristics:
  - 1) AWWA C606.
  - 2) Flexible joint type with rolled grooves.
  - 3) Minimum allowable pipe end separation:
    - a) 3-inch: 0.625-inch.
    - b) 4-inch: 0.125-inch.
    - c) 6-inch: 0.125-inch.
    - d) 8-inch: 0.125-inch.
    - e) 42-inch: 0.21- to 0.59-inches
  - 4) Minimum cold water working pressure ratings:
    - a) 16-inch coupling at pump discharge harnessed joint: 450 psi.
    - b) Couplings downstream of 16-inch trunnion mounted ball valve: 300 psi.
    - c) Couplings upstream of pumps (suction side): 150 psi.
- b. Non-restrained flexible coupling Style 230, restrained flexible type Style 232, restrained flexible type for dynamic joint deflection Style 233, manufactured by Victaulic, [www.victaulic.com](http://www.victaulic.com); or equal, having the following essential characteristics:
  - 1) Coupling type as shown on the drawings.
  - 2) Minimum cold water working pressure ratings:
    - a) 16-inch coupling at pump discharge harnessed joint: 450 psi.
    - b) Couplings downstream of 16-inch trunnion mounted ball valve: 300 psi.
    - c) Couplings upstream of pumps (suction side): 150 psi.

- 3) Conforms to AWWA C227:
  - 4) Steel material.
  - 5) Coupling housing: Arched, 2 or more segmented, split sleeve-type which when closed compresses elastomeric O-ring gaskets beneath arches of sleeve to create radial seal around pipe ends joined inside of coupling.
  - 6) Gaskets: Suitable for cold-water service.
- c. Restrained dynamic joint coupling for differential settlement: Model 257 manufactured by Victaulic, [www.victaulic.com](http://www.victaulic.com); or equal, having the following essential characteristics:
- 1) Pipe spools meet the requirements of ASTM A53, Type E or S, Grade B.
  - 2) 2-inch couplings for water quality sampling system:
    - a) Joints suitable for minimum of 2-inches of settlement.
    - b) Minimum 150 psi working pressure rating.
  - 3) 6-inch couplings for Pumping Plant No. 4 Sheep Spring turnout upstream of turnout building:
    - a) Joints suitable for minimum of 4-inches of settlement.
    - b) Minimum 300 psi working pressure rating.
  - 4) AWWA C606.
2. Stainless-steel:
- a. Restrained dynamic joint coupling for differential settlement: Model 257 manufactured by Victaulic, [www.victaulic.com](http://www.victaulic.com); or equal, having the following essential characteristics:
- 1) Pipe spools meet the requirements of ASTM A312, Type 304L or Type 316L.
  - 2) 2-inch couplings for water quality sampling system:
    - a) Joints suitable for minimum of 2-inches of settlement.
    - b) Minimum 150 psi working pressure rating.
  - 3) Joints suitable for minimum of 2-inches of settlement.
  - 4) Type 316 stainless-steel.
  - 5) AWWA C606.
- b. Grooved-end: Style 475 flexible coupling and Style 460H SS pipe end cap manufactured by Victaulic, [www.victaulic.com](http://www.victaulic.com); or equal, having the following essential characteristics:
- 1) Type 316 stainless-steel.

- 2) AWWA C606.
- 3) Flexible joint type with rolled or cut grooves.
- 4) Minimum working pressure rating: 150 psi.

X. Anchor bolts:

1. Expansion anchors or epoxy type anchor bolts with studs and epoxy as shown on the drawings:
  - a. Expansion anchors:
    - 1) CID A-A-1923A, Type 4.
  - b. Adhesive Anchors: Drilled type, installed with a chemical adhesive system:
    - 1) Adhesive: HIT-HY 200 epoxy adhesive manufactured by Hilti Corporation, [www.hilti.com](http://www.hilti.com); or equal, having the following essential characteristics:
      - a) Injectable two-component epoxy adhesive.
      - b) Stud and epoxy combination by same manufacturer.
      - c) End of stud: Double cut point.
      - d) Studs (threaded rods): ASTM A193, Grade B7.
      - e) Nuts: ASTM A193, Grade 2H.

Y. Flange insulation:

1. Flange isolating gasket kit complete with the “Trojan” type of gasket manufactured by Advanced Products and Systems, Inc., [www.apsonline.com](http://www.apsonline.com), or equal with the following essential characteristics:
  - a. Provide full-faced gaskets as shown on drawings. Outside diameter of gasket is same as outside diameter of flange.
  - b. Provide retainer with integral Nitrile sealing element (“Trojan” type).
  - c. Retainer material to be suitable for cold water service as recommended by gasket manufacturer.
  - d. One insulating sleeve and 2 insulating washers for each bolt. Material suitable for cold water service as recommended by gasket manufacturer.
  - e. Asbestos gaskets are not acceptable.
  - f. Prevent damage to gasket, gasket supplier to provide required bolt torques, recommended bolt tightening sequence, and flange face finish for insulating flanged joints.
  - g. Suitable for 300 psig cold water service.
  - h. ANSI/NSF 61 certified for contact with potable water.

**Z. Dielectric Unions:**

1. Dielectrically insulates pipe and valves with dissimilar metals to prevent accelerated corrosion due to galvanic action and stray current.
2. Bronze, brass or stainless-steel as noted on drawings.
3. Match male or female threads on piping and valves as needed.
4. ASME B1.20.1 NPT threads.
5. Match or exceed pressure rating of adjacent fittings.
6. Minimum 250 psi working pressure rating:
  - a. Series LF3003 manufactured by Watts, [www.watts.com](http://www.watts.com); or equal.
7. Minimum 300 psi working pressure rating:
  - a. Series D-3232 manufactured by Hart Industries, [www.hartindustries.com](http://www.hartindustries.com), Threaded Di-Electric Union manufactured by Penn Machined Works, [www.pennusa.com](http://www.pennusa.com); or equal.

**AA. Pipe Heads:**

1. 2:1 elliptical dished head.
2. ASME BPVC VIII.
3. Minimum 300 psi working pressure rating.

**BB. Air Vent Damper:**

1. Model No. 1504, Frost Safe two-way damper manufactured by Val-Matic Valve and Manufacturing Corporation, [www.valmatic.com](http://www.valmatic.com); or equal with the following essential characteristics:
  - a. For 4-inch air vent.
  - b. Suitable for connection to an AWWA Class D flange.
  - c. Allows 2-way flow.
  - d. Minimizes thermal exchange of cold and warm air in and out of valve vault.
  - e. Allows air vent to vent at full capacity.

**2.02 FABRICATION**

- A. Fabricate steel manifold piping in accordance with these specifications, as indicated on drawings, and in accordance with AWWA C200.
- B. Fabricate stainless-steel pipe in accordance with AWWA C220.
- C. Weld stainless-steel fittings to stainless-steel pipe in accordance with ASME B31.1.

- D. Longitudinal, girth, and spiral joints, other than field welds:
1. Double-welded butt joints with complete penetration.
  2. Stagger longitudinal joints.
  3. Longitudinal, girth, and spiral joints shall not intersect at outlet connections.
- E. Cut plates accurately to size and shape.
- F. Bend or roll plates to true circular with curvature continuous from edges of plates.
- G. Properly form edges to be joined by welding to suit type of welding and to allow complete penetration.
- H. Perform welding with a process that protects molten metal from atmosphere:
1. Where practicable, use automatic machines.
  2. Where weld metal is deposited in successive layers, clean each layer thoroughly before subsequent layer is deposited.
  3. Take particular care in aligning and separating edges of plates to be joined by butt welding so that complete penetration and fusion of welds will be ensured.
  4. After welding is complete, remove weld spatter.
- I. Protect work and operator from wind, rain, and snow during welding operations:
1. Welding is not permitted on wet surfaces or when temperature of steel is lower than 0 degrees F.
  2. Apply heat to welding areas as needed during field installation. At pipe surface temperatures between 0 and 32 degrees F, heat surface of areas within 3-inches of the point where a weld is to be started to at least 60 degrees F.
- J. Ends to be joined by a pipe coupling:
1. Exterior surface of pipe end to be connected with sleeve-type coupling shall be free from weld reinforcement (bead), seams, scars, dents, flats, or other defects likely to interfere with joint-sealing process in accordance with coupling manufacturer instructions.
- K. Flanges and flanged connections:
1. During attachment of flanges to associated steel manifold pipe, take adequate steps to ensure that face of flanges remains flat and perpendicular to centerline of attached piping.
  2. Limit irregularities or warping in face of flanges to 0.0015 of an inch measured from:
    - a. A high point on face of flange at an inside diameter to a corresponding low point on face of flange at an outside diameter, along a radial line, (concave orientation of flange is not permissible) and

- b. A high point on face of flange along a circumferential line at centerline of flange bolt holes, to a low point on face of flange along same circumferential line, within a distance equal to circumferential distance between every third bolt hole.
  3. Remove by machining, initial, residual, or latent irregularities or warping that remains in face of flange after its attachment to steel manifold piping that exceeds the above.
  4. After machining, flange thickness shall not be reduced below minimum thickness specified in AWWA C207, ASME B16.5, or as shown on drawings.
  5. Weld pipe flanges to the piping so that bolt holes straddle vertical centerline when in the installed position.
  6. Provide pipe flanges that connect to valve body flanges with same number of bolt holes, bolt pattern, bolt circle diameter, and face type, flat or raised, as valves to which they are connected.
- L. Continuously weld joints of flange supports and pipe supports.
- M. Solvent weld PVC socket type pipe fittings to PVC pipe using ASTM D2564 solvent and method in accordance with ASTM D2855:
  1. Do not subject solvent welded joints to internal or external loads or pressures until the solvent is fully cured.

## **2.03 CONTRACTOR SOURCE QUALITY TESTING**

- A. Flange Weld and Fixed Pipe Supports Testing:
  1. Test flange and Fixed Pipe Supports welds by magnetic particle or liquid penetrant method in accordance with AWS D1.1.
  2. Repair defects and retest weld.
- B. Coupling Restraint Ring Weld Testing:
  1. Test welds of restraint rings welded to pipe for split-sleeve restrained couplings by magnetic particle or liquid penetrant method in accordance with AWS D1.1.
  2. Repair defects and retest weld.
- C. Hydrostatic Pressure Testing:
  1. Straight sections of metal piping manufactured and hydrostatically tested in accordance with ASTM A53 or ASTM A139 need not be retested.
  2. Notify Government a minimum of 30-days before test.
  3. Government may witness hydrostatic test and calibration of pressure gauges.
  4. Use 2 or more pressure gauges with one being a recording type:
    - a. Upper limit of pressure gauges shall be between 1.5 and 3 times required test pressure. Calibrate pressure gauges with a deadweight tester.

- b. Calibrate at least 1 gauge, which is used for acceptance of test, within 30-days prior to use.
  - c. Make a time-pressure record of hydrostatic pressure test.
5. Furnish temporary supports, bulkheads, air vents, dead weight tester, and other equipment necessary to perform hydrostatic tests.
6. If flange is attached to piping section after piping section has been hydrostatically tested, piping section will not require retesting.
7. Water temperature for tests: Greater than 45 degrees F.
8. Vent air from test sections.
9. Fill each section with water and uniformly increase pressure until required test pressure is reached:
  - a. Hold test pressure for a minimum of 15-minutes.
  - b. Apply and release test pressure 3 successive times.
  - c. After each application, hold pressure to 2/3 of required pressure until welded joints and seams can be examined.
  - d. Repair defects. After defects are repaired repeat complete test procedure.
10. After hydrostatic testing is completed, cut sections for handling purposes on planes normal to pipe axis.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install steel manifold piping and stainless-steel water quality sampling piping to line and grade as shown on drawings:
  1. Install steel manifold pipe in accordance with the approved Pipe Installation Procedure.
- B. Prevent steel pipe and stainless-steel water quality sampling piping from being displaced or overstressed during concrete and backfill placement.
- C. Furnish and install supports and bracing as may be required to hold steel manifold piping in place, prevent distortion, and prevent flotation during erection, placing of concrete. Supports and bracing shall bear against the exterior pipe surface a minimum of 120-degrees of the pipe circumference and not create a point load on the pipe:
  1. Embedment of timber supports will not be permitted.
  2. If used for the support system, cables or chains may not bear directly against the steel pipe or concrete reinforcement.
- D. Contact between pipe and rebar will not be allowed.

- E. Install pipe spools with flanged connections so that bolt holes straddle vertical centerline when in installed position.
- F. Dielectrically insulate between dissimilar metals:
  - 1. Provide insulating type unions at threaded valve, pipe or fitting connections between dissimilar metals.
  - 2. Provide insulating flange kits for flanges of dissimilar metals.
- G. Install pipe couplings, gaskets, isolation kits and other appurtenances in accordance with manufacturer instructions.
- H. Install anchor bolts in accordance with manufacturer instructions.
- I. Field joints:
  - 1. Field joints shown on drawings are required to facilitate lining or installation of steel manifold piping.
  - 2. Allowable field joints for steel manifold piping:
    - a. AWWA and ASME B16.5 flanged joints per AWWA C604 or ASME PCC-1 respectively.
      - 1) Flanges shall be suitable for working pressure of adjacent pipe.
    - b. Full-penetration butt welds.
    - c. Double welded lap joints, or double welded butt strap joints.
    - d. Threaded couplings for pipe less than 4-inches in diameter.
  - 3. Welded field joints in accordance with AWWA C206.
  - 4. Prepare field welded surfaces and recoat in accordance with Section 09 96 20 – Coatings.
  - 5. Allowable field joints for stainless-steel water quality sampling piping:
    - a. Full penetration butt welds.
    - b. Flanges of the same pressure rating as shown on the drawings.
  - 6. Allowable field joints for PVC piping:
    - a. Schedule 80 ASTM D2467 fittings.
    - b. Stainless-steel grooved couplings.
- J. Steel manifold piping and stainless-steel water sampling piping earthwork:
  - 1. In accordance with Section 31 23 22 – Pipe Trench Earthwork.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Water Quality Sampling Pipe System:

1. Hydrostatic or pneumatic leakage testing:
  - a. Perform hydrostatic or pneumatic leakage testing after installation but prior to embedding piping.
  - b. Provide thrust blocks or other means of thrust restraints to prevent piping, valves and other equipment from being damaged during the test.
  - c. Preliminary test:
    - 1) Apply a pressure of 10 psi to reveal major leaks. Vent pressure, make appropriate repairs and repeat test.
  - d. Leakage testing:
    - 1) Apply a pressure of 25 psi. Hold the pressure for 10-minutes and examine the piping for leaks.
    - 2) If leaks are found, vent pressure, make appropriate repairs and repeat test.
    - 3) Leaks may be detected visually (water), by soap bubbles, scented gas, ultrasonic or other suitable means.
- B. Nondestructive Testing of Field Welds of Steel Pipe:
  1. Test all welds in accordance with AWWA C206 and this specification.
  2. Complete inspections and tests as work progresses in presence of COR and in accordance with AWS D1.1.
  3. When welds are found to be defective by the standards of AWS, repair welds in accordance with AWS D1.1 and reexamine welds to ensure the adequacy of repairs.
  4. Visual Inspection: Visually inspect all welds following procedures, techniques, and standards of AWS D1.1.
  5. Testing of full penetration joints:
    - a. Ultrasonic methods in accordance with AWS D1.1.
  6. Testing of partial penetration joint field welds and fillet field welds, including testing of double welded butt strap joints or double welded lap joints:
    - a. Magnetic particle testing: ASTM E709.
    - b. Dye penetrant: ASTM E165.
    - c. Standards of acceptance for both types: AWS D1.1.
    - d. Caulking or peening of defective welds is not permitted.
    - e. Repair and retest unsatisfactory welds.
  7. Inspect all double lap welded and butt strap joints by air and soap test:
    - a. AWWA C206.
    - b. Test the joints by shop drilling and tapping for a 1/8-inch or 1/4-inch national pipe thread in the lap end of the pipe.

- c. Apply 40 psi, gauge, of air into the connection between the two fillet welds and maintain for a period of 5-minutes.
- d. Paint the welds with a soap solution.
- e. Mark any leaks indicated by the escaping air bubbles.
- f. Repair welds at leak locations in accordance with AWS D1.1 and AWWA C206 and retest.
- g. Close the threaded openings with pipe plugs.
- h. Seal weld the pipe plugs and grind the weld smooth.
- i. Submit test results to COR within one week after testing.
- j. Prepare field welded surfaces and recoat in accordance with Section 09 96 20 – Coatings.

C. Nondestructive Testing of Field Welds of Stainless-Steel Pipe:

1. 100 percent examine using dye or liquid penetrant (PT) in accordance with ASTM E165:
  - a. Repair and retest unsatisfactory welds.

**3.03 LINING AND COATING**

- A. Refer to Section 09 96 20 – Coatings.

**END OF SECTION**

**SECTION 35 22 14**  
**VALVES AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Valves and Equipment:

1. Payment: Lump sum prices offered in the Price Schedules for various types and sizes of valves and equipment provided as shown on drawings

**1.02 DEFINITIONS**

- A. Details of valves and equipment are shown on drawings: 1695-D-60595 through 1695-D-60624 and 1695-D-60389 through 1695-D-60395.

**1.03 REFERENCE STANDARDS**

A. American National Standards Institute (ANSI)

1. ANSI/NSF 61-17                      Drinking Water System Components –  
Heath Effects
2. ANSI/NSF 372-16                    Drinking Water System Components – Lead  
Content

B. American Petroleum Institute (API)

1. API 6D -2014                         Pipeline and Piping Valves, Twenty –  
Fourth Edition

C. American Society of Mechanical Engineers (ASME)

1. ASME B16.5-2017                    Pipe Flanges and Flanged Fittings: NPS 1/2  
through NPS 24 Metric/Inch
2. ASME B16.21-2016                   Nonmetallic Flat Gaskets for Pipe Flanges
3. ASME B16.34-2017                   Valves – Flanged, Threaded and Welding  
End
4. ASME B16.42-2016                   Ductile Iron Pipe Flanges and Flanged  
Fittings, Classes 150 and 300
5. ASME B40.100-2013                   Pressure Gauges and Gauge Attachments

D. American Society of Sanitary Engineering

1. ASSE (Plumbing) 1003-2009       Performance Requirements for Water  
Pressure Reducing Valves for Domestic  
Water Distribution Systems

- E. ASTM International (ASTM)
1. ASTM A216/A216M-18 Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
  2. ASTM A536-84 (2014) Ductile Iron Castings
- F. American Water Works Association (AWWA)
1. AWWA C207-18 Steel Pipe Flanges for Waterworks Service, Sizes 4 In. through 144 In.
  2. AWWA C504-15 Rubber-Seated Butterfly Valves
  3. AWWA C507-18 Ball Valves, 6 In. Through 60 In. (150 mm Through 1,500 mm)
  4. AWWA C508-17 Swing-Check Valves for Waterworks Service, 2-In. through 48-In. (50-mm Through 1200-mm) NPS
  5. AWWA C509-15 Resilient-Seated Gate Valves for Water-Supply Service
  6. AWWA C512-15 Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service
  7. AWWA C515-15 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
  8. AWWA C530-17 Pilot Operated Control Valves
  9. AWWA C542-16 Electric Motor Actuators for Valves and Slide Gates
- G. Manufacturers Standardization Society of the Valves and Fittings Industry (MSS)
1. MSS SP-61-2013 Pressure Testing of Valves
  2. MSS SP-68-2017 High Pressure Butterfly Valves with Offset Design
  3. MSS SP-72-2010a Ball Valves with Flanged or Butt-Welding Ends for General Service
  4. MSS SP-80-2013 Bronze Gate, Globe, Angle and Check Valves
  5. MSS SP-110-2010 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved, and Flared Ends
- H. National Electrical Manufacturing Association Standards (NEMA)
1. NEMA ICS 5-2017 Industrial Control and Systems: Control Circuit and Pilot Devices

- |    |                |  |
|----|----------------|--|
| 2. | NEMA MG 1-2016 | Motors and Generators  |
| 3. | NEMA 250-2014  | Enclosures for Electrical Equipment<br>(1,000 Volts Maximum) |

#### **1.04 SUBMITTALS**

- A. Submit the following in accordance with the requirements of Sections 01 33 00 – Submittals and 01 33 26 – Electrical Drawings and Data.
- B. RSN 35 22 14–1, Commercial Products Data:
1. Pressure gauges.
  2. Pressure reducing valves for sampling ports.
  3. Pressure switches.
  4. Pressure transmitters.
  5. Portable gasoline engine powered hydraulic power unit.
  6. Portable hydraulic valve operator.
  7. Manually operated ball valves.
  8. Check valves.
  9. Globe valves.
  10. Gate valves.
  11. Flap valves.
  12. Air valves:
    - a. Include calculations and product data for the air valves on the Pump Discharge Head assembly.
  13. AWWA butterfly valves for buried service.
  14. AWWA butterfly valves with manual actuators for exposed service.
  15. Manually operated 300 pounds per square inch (psi) rated butterfly valves for exposed service:
    - a. Include limit switches where specified.
  16. Manually operated 300 psi rated butterfly valves for buried service.
  17. Manually operated high performance butterfly valves.
  18. Pilot-Operated Control Valves:
    - a. 12-inch pilot-operated pressure sustaining valves with anti-cavitation trim in pumping plants.
    - b. 4-inch and 8-inch pilot-operated flow control valves with solenoid shut-off valve in the turnout buildings.

- c. 6-inch pilot-operated pressure reducing valve in Temporary Construction Water Line at Pumping Plant No. 4
  - d. 3-inch pilot-operated combination pressure reducing and flow control valves with anti-cavitation trim in the turnout buildings.
    - 1) Index.
    - 2) Parts identification lists.
    - 3) Lists of special tools and accessories.
    - 4) Schematics showing pilot-operated control system, connections and manufacturer recommended componentry:
      - a) Include solenoid shut-off valve as applicable.
    - 5) Wiring diagram for valves with solenoid shut-off.
    - 6) Instructions for installing, adjusting, operating, lubricating, and maintaining equipment.
    - 7) Cavitation chart showing flow rate, differential pressure, valve characteristic curve ( $C_v$  versus percent open), and system velocity.
19. Motor-Operated Trunnion Mounted Ball Valve Data:
- a. Commercial products (catalog) data including:
    - 1) Manufacturer's name.
    - 2) Model number.
    - 3) Bill of material.
    - 4) Name plate list.
    - 5) Settings for the limit switches and the torque switches.
  - b. Torque calculations showing that the motor operator is of sufficient size to seat or unseat the valve and hold the valve at any intermediate position under the maximum unbalanced pressure conditions.
  - c. Valve data:
    - 1) Maximum torque required (foot-pounds).
    - 2) Test data of rated flow coefficient ( $C_v$ ). Provide data in graph or table format with data points at a maximum of 10 degree intervals, for disk angles of 10 degree through 90 degree.
  - d. Motor data:
    - 1) Locked rotor torque (foot-pounds).
    - 2) Full load torque (foot-pounds).
    - 3) Horsepower rating (horsepower).
    - 4) Voltage rating (volts).

- 5) Locked rotor amps (amperes).
  - 6) Full load amps (amperes).
  - 7) Time duty rating (minutes).
  - 8) Assembly drawings.
  - 9) Schematic and wiring diagrams for each motor operated ball valve:
    - a) Show schematic details for all portions of actual circuitry.
    - b) Show motor and switch terminals for the motor operated ball valves.
    - c) Clearly mark the interface for remote devices.
    - d) Show designations on device terminals and wire numbers.
    - e) Show spare contacts.
20. Motor-Operated Butterfly Valve Data:
- a. 300 psi rated butterfly valves.
  - b. Commercial products (catalog) data including:
    - 1) Manufacturer's name.
    - 2) Model number.
    - 3) Bill of material.
    - 4) Name plate list.
    - 5) Settings for the limit switches and the torque switches.
  - c. Torque calculations showing that the motor operator is of sufficient size to seat or unseat the valve and hold the disk at any intermediate position under the maximum unbalanced pressure conditions.
  - d. Valve data:
    - 1) Maximum torque required (foot-pounds).
    - 2) Test data of rated flow coefficient (Cv). Provide data in graph or table format with data points at a maximum of 10 degree intervals, for ball angles of 10 degree through 90 degree.
  - e. Motor data:
    - 1) Locked rotor torque (foot-pounds).
    - 2) Full load torque (foot-pounds).
    - 3) Horsepower rating (horsepower).
    - 4) Voltage rating (volts).
    - 5) Locked rotor amps (amperes).
    - 6) Full load amps (amperes).

- 7) Time duty rating (minutes).
  - 8) Assembly drawings.
  - 9) Schematic and wiring diagrams for each motor operated butterfly valve:
    - a) Show schematic details for all portions of actual circuitry.
    - b) Show motor and switch terminals for the motor operated butterfly valves.
    - c) Clearly mark the interface for remote devices.
    - d) Show designations on device terminals and wire numbers.
    - e) Show spare contacts.
21. Valve boxes for buried valves.
22. Piping and valve insulation jackets:
  - a. Provide calculations demonstrating insulation material is adequate to prevent freezing from generally accepted temperatures at location being installed.
23. Air vent damper.
- C. RSN 35 22 14-2, Check Prints:
1. In accordance with section 01 33 26 – Electrical Drawings and Data.
- D. RSN 35 22 14-3, Field Installation Procedures.
1. Pilot-operated control valves:
    - a. Circuit schematic of pilot-operating system:
      - 1) Include solenoid shut-off valve data as applicable.
- E. RSN 35 22 14–4, Shop Testing Certifications and Reports:
1. Hydrostatic pressure testing certifications and pressures used in testing valves:
    - a. AWWA Class 150B and 300 psi rated butterfly valves tested in accordance AWWA C504.
    - b. Trunnion mounted ball valves tested in accordance with API 6D.
    - c. Pilot-operated control valves.
  2. Reports of valve operation with motor-operators at working pressure:
    - a. Motor-operated 300 psi butterfly valves.
    - b. Motor-operated trunnion mounted ball valves.
- F. RSN 35 22 14–5, Service Manuals:
1. For each valve and equipment type listed below, include:

- a. Complete parts identification lists including clearly identified recommended spare parts.
  - b. Lists of special tools and accessories.
  - c. Detailed instructions for installing, adjusting, operating, lubricating, and maintaining the equipment.
2. Manuals for the following:
- a. Pressure reducing valves for sampling ports.
  - b. Pressure switches.
  - c. Pressure gauges.
  - d. Pilot-operated control valves.
  - e. Pressure transmitters.
  - f. Portable gasoline engine powered hydraulic power unit.
  - g. Portable hydraulic valve operator.
  - h. Globe valves.
  - i. Gate valves.
  - j. Check valves.
  - k. Air valves.
  - l. Ball valves with manual actuators.
  - m. Manually operated AWWA Class 150B butterfly valves.
  - n. Manually operated 300 psi rated butterfly valves.
  - o. High performance butterfly valves.
  - p. Motor-Operated Valves:
    - 1) Motor-Operated Trunnion Mounted Ball Valves.
    - 2) Motor-Operated Butterfly Valves.
    - 3) Final “As-built” drawings, including:
    - 4) Schematics and wiring diagrams.
    - 5) Catalog data sheets for each device or item of equipment.
    - 6) Half-size prints of drawings including nameplate list and bill of material.

## **1.05 DESIGN REQUIREMENTS**

- A. Combination air valves on pump discharge head assembly:
1. Design and provide air valve assembly for air valves on pump discharge head assemblies.
  2. Provide calculations and product data demonstrating that the air valve is the size for the application:

- a. ~~Calculations to be stamped by a professional engineer registered in State of New Mexico.~~
- 3. Air valve to allow sufficient air inlet and air outlet for operating conditions, including air accumulation under pressure.
- 4. 2-inch NPT port is being provided on each pump can for the air valve. See Section 33 12 71 – Vertical Pumping Units paragraph 2.01 A. 4. L:
  - a. Coordinate with pump manufacturer to provide correct fitting size and type to match air valve size required by calculations.
- 5. Provide an isolation valve between pump discharge head assembly and air valve.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Take precaution during loading, transportation, unloading, storage, and laying, to prevent damage to the valves and equipment:
  - 1. Repair damage to the valves and equipment as directed if, in the opinion of Contracting Officer Representative (COR), a satisfactory repair can be made; otherwise replace damaged valves and equipment.
  - 2. Ship, handle and store according to manufacturer's instructions.

## **PART 2 PRODUCTS**

### **2.01 EQUIPMENT**

- A. Valves and equipment materials:
  - 1. NSF/ANSI 61 certified.
  - 2. NSF/ANSI 372 certified lead-free.
  - 3. Suitable for potable water.
  - 4. Materials suitable for free chlorine residual exposure:
    - a. Typical free chlorine residual concentration: Maximum 4 milligrams per liter (mg/l).
- B. Valves to operate and seal with flow in either direction (bi-directional). Provide double seated valves or other modifications as needed for sealing in either direction.
- C. Valve Body Flange Faces and Flanges:
  - 1. Valve manufacturers are responsible for providing the correct flange face gasket surface finish.
  - 2. Provide spiral or concentric serrated grooved flange face gasket surface finishes that are suitable for the gasket material provided and for the operating pressures.
  - 3. Valve flange bolt patterns to match pipe flanges.

- D. Furnish valves and actuators of same type and size from same manufacturer.
- E. Provide one extra set of seats for each size and type of butterfly valve and for each size and type of ball valve:
1. Spare seats are not required for ball valves with no standard replaceable seat design.
- F. Gaskets:
1. For flat faced and some raised face flanges: Multi-Swell Style 3760-U manufactured by Garlock, [www.garlock.com](http://www.garlock.com); or equal with the following essential characteristics:
    - a. Minimum 500 psi cold water pressure rating.
    - b. Use this gasket only on raised face flanges if hydrostatic test pressure for that section of pipe is less than the minimum 500 psi cold water pressure rating.
    - c. Dimensional requirements of AWWA C207 or ASME B16.5 as shown on drawings.
    - d. Flat, full face, or ring type.
    - e. NSF 61 listed.
    - f. Suitable for cold water service.
    - g. Minimum 1/16 inch thick.
  2. For ASME B16.5 Class 300 raised face flanges: Gylon Style 3505, manufactured by Garlock [www.garlock.com](http://www.garlock.com); or equal, having the following essential characteristics:
    - a. Nonmetallic ring type for raised face flanges.
    - b. Minimum 675 psi cold water pressure rating.
    - c. NSF 61 listed.
    - d. Suitable for cold water service.
    - e. Minimum 1/16-inch thick.
- G. Pressure Gauges:
1. Model 213.40 manufactured by Wika Instrument, LP, [www.wika.us](http://www.wika.us), Type 1279 manufactured by Ashcroft, Inc. [www.ashcroft.com](http://www.ashcroft.com); or equal, having the following essential characteristics:
    - a. Range displayed on pressure gauge upstream of pumps at pressure switch and sampling station: -14.7 psi to 30 psi.
    - b. Range displayed on 16-inch pump discharge pipe pressure gauge at pressure switch: 0 psi to 600 psi.

- c. Range displayed on 42-inch discharge pipe pressure gauge: 0 psi to 400 psi.
  2. Bronze bourdon-tube, adjustable-movement type:
    - a. Case material: Brass, aluminum alloy, phenolic or stainless-steel.
    - b. Dust-proof and moisture-proof case.
    - c. Glycerin liquid filled.
    - d. 4-inch to 4 1/2-inch diameter or larger dial.
    - e. Dial: White with black markings.
    - f. Black indicating pointer.
    - g. Red maximum reading pointer indicating highest pressure attained.
    - h. Shatter resistant window.
    - i. Conform to ASME B40.100, Grade A accuracy or better.
    - j. Bottom connects to 0.25-inch diameter male pipe connection.
- H. Pilot-Operated Control Valves:
  1. General:
    - a. AWWA C530.
    - b. Suitable for bolting to AWWA Class F steel pipe flanges.
    - c. During valve operation, water vented from upper pressure chamber of main valve (when the main valve is opening) shall be directed into pilot piping so that it discharges into downstream side of main control valve.
    - d. Diaphragm or piston operated.
    - e. Pressure gauges integral to the main control valve to measure upstream and downstream pressures.
    - f. Drip tight shut-off.
    - g. Sealing disk: rubber, synthetic rubber, or Buna-N.
    - h. Suitable for cold water pressures up to 300 psig.
    - i. ASTM A536 ductile iron or ASTM A216 WCB cast steel.
    - j. Stainless-steel trim.
    - k. Control system components to be manufactured by the same company as the main valve.
      - 1) Include orifice plates if applicable.
    - l. Pilot piping for the valves:
      - 1) Design, furnish, and test per manufacturer's recommendations.

- 2) Hydraulic (water) operated control pilots with seamless copper or stainless-steel tubing.
  - 3) Heavy-duty, ball-type shut off valves for isolation manually-operated pilot control system.
  - 4) Opening and closing speed control valves.
  - 5) Pilot "Y" strainers with blowdown valves.
  - 6) Check valves.
  - 7) Atmospheric drain.
  - 8) Pressure gauges.
- m. Valve visual position indication.
- 1) Stainless-steel position indicator rod.
  - 2) Brass or stainless-steel protective housing which allows viewing of valve position from two sides.
  - 3) Manual air purge valve at top of assembly.
  - 4) Pyrex tube or covers to enclose stem inside housing.
- n. Furnish and install pilot piping and associated valving and fittings as recommended by the flow control valve manufacturer between the flow control valve and the orifice plate or the sensing line fitting, depending on the flow control valve manufacturer.
- o. Shop Testing:
- 1) In accordance with manufacturer's recommended testing requirements.
  - 2) Supply documentation certifying test procedure and pressures used.
2. Twelve-Inch Diameter Pressure Sustaining/Pipe Filling Valve:
- a. Model S106 manufactured by Singer Valve, [www.singervalve.com](http://www.singervalve.com), Model No. 50-01KO, manufactured by Cla-Val Company, [www.cla-val.com](http://www.cla-val.com), Model A108 Series manufactured by Apollo Valves, [www.apollovalves.com](http://www.apollovalves.com); or equal, having the following essential characteristics:
- 1) Full port, globe style.
  - 2) Automatically sustains upstream pressure to specified pressure.
  - 3) Factory set pressure sustaining pilot spring to specified pressure setting.
  - 4) Pressure sustaining settings shall be fully adjustable.
  - 5) Anti-cavitation trim suitable for pressure dissipation from specified upstream pressure to atmosphere without damaging cavitation.

- 6) Pumping Plant No. 4:
    - a) Upstream pressure: 228 psi.
    - b) Downstream pressure: atmospheric pressure.
    - c) Flow: 11.92 cubic feet per second (5,800 gallons per minute).
  - 7) Pumping Plant No. 7:
    - a) Upstream pressure: 251 psi.
    - b) Downstream pressure: atmospheric pressure.
    - c) Flow: 10.1 cubic feet per second (5,352 gallons per minute).
3. Flow Control Valves with Solenoid Shut-Off Valves:
- a. Model 106-SC manufactured by Singer Valve, [www.singervalve.com](http://www.singervalve.com), Model No. 43-01, manufactured by Cla-Val Company, [www.cla-val.com](http://www.cla-val.com), Model A115 Series manufactured by Apollo Valves, [www.apollovalves.com](http://www.apollovalves.com), Model 120-01 manufactured by OCV Control Valves, [www.controlvalves.com](http://www.controlvalves.com); or equal, having the following essential characteristics:
    - 1) Located in Sheep Springs and Tohatchi turnout buildings
    - 2) Full port, globe style.
    - 3) Automatically controls flow through valve to specified flow rate.
    - 4) Flow control settings shall be field adjustable.
    - 5) Orifice plates:
      - a) Install orifice plates and valves as shown on the drawings. Actual valve and orifice plate locations may vary depending on control valve manufacturer's recommendations.
      - b) Provide orifice plate bore size in accordance with manufacturer's recommendations to meet required flow rates.
    - 6) Maximum pressure drop through control valve: 3-5 psi.
    - 7) Solenoid shut-off valve:
      - a) 120 vac.
      - b) Causes control valve to close on loss of power.
    - 8) Limit switch:
      - a) Adjustable.
      - b) Integral to control valve.
      - c) Actuates when valve is fully closed.

- d) Double pole double pole switches rated at 1 amp at 125 vdc and 120 vac.
- e) UL rated with NEMA 4 enclosure.
- 9) Pumping Plant No. 4 Sheep Springs turnout:
  - a) Upstream pressure: 228 psi.
  - b) Flow rate: 0.48 cubic feet per second.
  - c) Valve size: 4-inch diameter valve.
- 10) Pumping Plant No. 7 Tohatchi turnout:
  - a) Upstream pressure: 251 psi.
  - b) Flow rate: 1.99 cubic feet per second.
- 4. Valve size: 8-inch diameter valve. Combination Pressure Reducing and Flow Control Valves:
  - a. Model 106-RF-PR-AC manufactured by Singer Valve, [www.singervalue.com](http://www.singervalue.com), Model No. 100-KO, manufactured by Cla-Val Company; or equal, having the following essential characteristics:
    - 1) Located in Sheep Springs and Tohatchi turnout buildings
    - 2) Full port or reduced port, globe style.
    - 3) Automatically controls flow through the valve and downstream pressure to specified flow rate and pressure.
    - 4) Pressure reducing and flow control settings shall be field adjustable.
    - 5) Anti-cavitation trim suitable for pressure dissipation from specified upstream pressure to atmosphere without damaging cavitation.
    - 6) Orifice plates:
      - a) Install orifice plates downstream of the valve as shown on the drawing. Actual valve and orifice plate locations may vary depending on control valve manufacturer's recommendations.
      - b) Provide orifice plate bore size in accordance with manufacturer's recommendations to meet required flow rates.
  - 7) Pumping Plant No. 4 Sheep Springs turnout:
    - a) Flow: 0.41 cubic feet per second.
    - b) Upstream pressure: 228 psi.
    - c) Downstream pressure: 5-20 psi.
    - d) Valve size: 3-inch diameter valve.
  - 8) Pumping Plant No. 7 Tohatchi turnout:

- a) Flow: 0.41 cubic feet per second.
- b) Upstream pressure: 251 psi.
- c) Downstream pressure: 5-20 psi.
- d) Valve size: 3-inch diameter valve.

5. Six-inch Diameter Pressure Reducing Valve:

- a. Model 106-PR-AC manufactured by Singer Valve, [www.singervalve.com](http://www.singervalve.com), Model No. 90-01KO, manufactured by Cla-Val Company; or equal, having the following essential characteristics:

- 1) Located on Temporary Construction Water Line at Pumping Plant No. 4.
- 2) Full port, globe style.
- 3) Minimum upstream pressure: 117 psi.
- 4) Maximum upstream pressure: 142 psi.
- 5) Downstream pressure: 13 psi.
- 6) Minimum flow: 1.5 cubic feet per second:
  - a) If lower minimum flow rate is required, consult valve manufacturer.
- 7) Maximum flow: 2 cubic feet per second.
- 8) Pressure reducing pilot spring factory set at 13 psi.
- 9) Anti-cavitation trim suitable for specified pressure dissipation without damaging cavitation.
- 10) Valve pressure reducing settings shall be fully adjustable.

I. Manually Operated Ball Valves:

1. Less than 4-inches in diameter:

a. Threaded connections:

- 1) 76F-100-A series manufactured by Apollo Valves, [www.apollovalves.com](http://www.apollovalves.com); or equal, having the following essential characteristics:
  - a) Bubble tight at the rated pressure in either direction and suitable for operation after long periods of inactivity.
  - b) MSS SP-110.
  - c) Body: Full ported, carbon steel or stainless-steel as shown on the drawings.
  - d) Ball: Stainless-steel.
  - e) Valve stem: Stainless-steel.

- f) Packing gland: Stainless-steel.
  - g) Female threaded ends.
  - h) Cold water pressure rating of not less than 500 psi.
  - i) NSF 61 and NSF 372 compliant.
  - j) Locking device if indicated on the drawings.
- b. Flanged connections:
- 1) 3-inch ball valves in turnout buildings.
    - a) Model 4000D or 4001 manufactured by American Valve, [www.americanvalve.com](http://www.americanvalve.com), NS series manufactured by A-T Controls, Inc. or equal; having the following essential characteristics:
      - i. MSS-SP-72.
      - ii. Suitable for cold water pressures up to 300 psig.
      - iii. Resilient seats.
      - iv. Carbon steel, ductile iron, or stainless-steel body.
      - v. Carbon steel ball, stainless-steel ball or stainless-steel ball fused with polytetrafluoroethylene (PTFE).
      - vi. Stainless-steel stem.
      - vii. Bubble tight at the rated pressure in either direction and suitable for operation after long periods of inactivity.
      - viii. Handle or handwheel with geared operator as recommended by manufacturer.
      - ix. Designed to operate at a full unbalanced head of 300 psi.
2. 6-inches in diameter for Pumping Plant No. 7 blowoff:
- a. AWWA C507.
  - b. AWWA Class 300.
  - c. Bubble tight at the rated pressure in either direction and suitable for operation after long periods of inactivity.
  - d. Suitable for bolting to AWWA Class F steel pipe flanges.
  - e. Suitable for buried service.
  - f. Worm gear or traveling nut manual actuator in accordance with AWWA C507.
  - g. Rim pull and component strength meets AWWA C507.

- h. Provide gears of the self-locking type, designed to hold the valve in all positions without fluttering or creeping.
- i. Provide operators that will open and close the valves under maximum unbalanced pressure condition of 300 psi:
- j. Valve box.
- k. 2-inch square-nut operator.
- l. Provide extension stems where required to raise the operating nut to within 6 inches of the top of valve box as shown on the drawings:
  - 1) The extension stem shall not be attached with set screws; only use roll pins or bolt locking nut that extends through extension and valve shaft.

J. Check Valves:

1. Tilting Disc:

- a. Series 9700 manufactured by Val-Matic Valve and Manufacturing Corp., [www.valmatic.com](http://www.valmatic.com), TD Series manufactured by Crispin Valves, [www.crispinvalve.com](http://www.crispinvalve.com), Series 800B manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com); or equal, having following essential characteristics:
  - 1) Tilting-disc type furnished with a hydraulic dampening device that will permit unrestricted opening of the valve and a controlled rate of closure.
  - 2) Metal to metal seated.
  - 3) Minimum working pressure rating of 300 psig, cold water service.
  - 4) Leakage at rated pressure: One fluid ounce per diameter inch per hour.
  - 5) Suitable for bolting to AWWA Class F steel pipe flanges.
  - 6) Valve body: ASTM A536 grade 65-45-12 ductile iron or ASTM A216 grade WCB cast steel.
  - 7) Valve body with integral flanges (not wafer style).
  - 8) Flat face flanges: Provide spiral or concentric serrated grooved flange face gasket surface finishes that are suitable for flat gasket material.
  - 9) Centrifugally cast bronze body seat.
  - 10) Stainless-steel pivot pin.
  - 11) Seat and disk rings: Replaceable without machining in the field.
  - 12) Hydraulic dampening device: Consists of a dashpot or plunger device designed to prevent slamming by controlling the rate of closure during the final portion of disc travel. The point at which

the hydraulic dampening device begins to control the closure rate is externally adjustable from 0 to 10 percent of disc travel.

- 13) Provide a disc position indicator on the shaft.
- 14) Provide bottom mounted oil dashpot (buffer).

2. Silent:

- a. Series 1800 manufactured by Val-Matic Valve and Manufacturing Corp., [www.valmatic.com](http://www.valmatic.com), Series CSC – 600A manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com); or equal, having following essential characteristics:

- 1) Silent operating type.
- 2) Globe style.
- 3) Center guided, spring loaded disc.
- 4) All parts to be field replaceable.
- 5) Resilient seal.
- 6) Zero leakage.
- 7) Minimum working pressure rating of 300 psig, cold water service.
- 8) Suitable for bolting to AWWA Class F steel pipe flanges.
- 9) Valve body: ASTM A536 grade 65-45-12 ductile iron or ASTM A216 grade WCB cast steel.
- 10) Disc: ASTM A351 grade CF8M stainless-steel.
- 11) Seat and compression spring, type 316 stainless-steel.
- 12) Valve body with integral flanges (not wafer style).
- 13) Flat face flanges: Provide spiral or concentric serrated grooved flange face gasket surface finishes that are suitable for flat gasket material.

K. Globe Valves:

1. 3/4 inch and 2-inch for filling and draining air chambers. Lead free brass or bronze, forged or cast steel or stainless-steel.
2. MSS SP-80.
3. Cold water working pressure not less than 300 psig.
4. Outside screw and yoke.
5. Threaded.
6. Full port.
7. Manually actuated.
8. Suitable for potable water service.

9. Suitable for use as pipe filling valves to bypass the 12-inch butterfly isolation valves for the air chambers as shown on the drawings.
10. Bubble tight at the rated pressure in either direction and suitable for operation after long periods of inactivity.

L. Gate Valves:

1. Buried service:
  - a. AWWA C509 or AWWA C515.
  - b. Cast ferrous valve components shall be made of cast or ductile iron.
  - c. Non-rising stem.
  - d. Wrench nut operated.
  - e. Valve ends shall be flat faced flanges and shall match the drilling dimensions and pattern of AWWA C207 Class D flanges.
  - f. Wedges shall be fully encapsulated with EPDM or SBR rubber.
  - g. Operating nuts shall be 2-inch square and shall be cast or ductile iron.
  - h. Cold water working pressure shall be a minimum of 150 psig.
  - i. Valve shall be suitable for buried service.
  - j. Zero leakage.
2. Plant service in turnout buildings:
  - a. Series A-2361 manufactured by Mueller Co. LLC, , High Pressure Resilient Wedge Gate Valve manufactured by Kennedy Valve, [www.kennedyvalve.com](http://www.kennedyvalve.com); or equal, having the following essential characteristics:
  - b. AWWA C509 or AWWA C515.
  - c. Ductile iron bonnet, body and wedge shall be made of ductile iron.
  - d. Non-rising stem.
  - e. Handwheel.
  - f. Valve ends shall be flat faced flanges and shall match the drilling dimensions and pattern of AWWA C207 Class F flanges.
  - g. Wedges shall be fully encapsulated with EPDM or SBR rubber.
  - h. Minimum cold-water working pressure rating of 300 psig.
  - i. Zero leakage.

M. Air Valves:

1. General:
  - a. Potable (clean) water service.

- b. Single or dual body.
  - c. Stainless-steel internal parts such as guides, bushings, and screws.
  - d. Stainless-steel floats.
  - e. Float-pivot supports: Brass, bronze, stainless-steel, or cast iron.
  - f. Spare parts:
    - 1) 1 complete set of air valve spare parts for each size and type including:
      - a) Seats, lever, and gasket.
      - b) Additional parts recommended by manufacturer.
      - c) Box and clearly label box:
        - i. Include detailed list of spare parts inside box.
      - d) Store in location as directed by COR.
2. Combination air valves:
- a. Remains open for filling line until water has displaced air at point of attachment of valve assembly after which it closes.
  - b. Opens when pressure in pipeline drops sufficiently to create a vacuum.
  - c. Releases trapped air when the pipeline is under pressure.
  - d. Furnish with ball valves in accordance with paragraph 2.01 I.:
    - 1) One ball valve on top, permits checking effectiveness of air valve.
    - 2) One ball valve on bottom, allows valve to be drained.
    - 3) For dual body valves, provide full port isolation ball valve between main body and air release valve.
  - e. 1/2- inch air valves at water quality sampling station, 2-inch air valves on pump cans and 6-inch air valve in manhole upstream of Pumping Plant No. 7 water storage tank:
    - 1) Model 100S/22.7 (1/2-inch), Model 201C.2 and Models 102S/38.5 or 202C.2 (2-inch), Model and 106S/45 or 206C (6-inch) manufactured by Val-Matic Valve and Manufacturing Corporation, [www.valmatic.com](http://www.valmatic.com); Models 145C (2-inch) or 1806/200 (6-inch) manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com), Model C5 (1/2-inch) and Models C20, UL20 or AL20/M5 (2-inch) and C61 or AL61/PL10 (6-inch) manufactured by Crispin Valves, [www.crispinvalve.com](http://www.crispinvalve.com); or equal, having following essential characteristics:
      - a) AWWA C512.
      - b) Air release orifice sizes:
        - i. 1/2-inch: 1/8-inch, minimum.

- ii. 2-inch on pump cans: 3/32-inch, minimum.
    - iii. 6-inch: 5/16-inch, minimum.
  - c) Cold-water pressure rating for air valves:
    - i. 150 psi, minimum.
  - d) Operating pressure for seat materials:
    - i. 1/2-inch: Soft seats suitable for 0 to 25 psi.
    - ii. 2-inch on pump cans and 6-inch: Soft seats suitable for 0 to 150 psi.
  - e) Cold-water pressure rating for body: 300 psi, minimum.
  - f) Actuated by a float or floats.
  - g) 6-inch air valve: Provide with hood.
- f. 1-inch air valves at Sheep Springs turnout building and 2-inch air valves at Tohatchi turnout building:
  - 1) Models 201C.2 or 101S/38.5 (1-inch) and Models 202C.2 or 102S/38.5 (2-inch) manufactured by Val-Matic Valve and Manufacturing Corporation, [www.valmatic.com](http://www.valmatic.com); 143C (1-inch) or 145C (2-inch) manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com), Models AL10/M5 or UL10 (1-inch) and AL20/M5 or UL20 (2-inch) manufactured by Crispin Valves, [www.crispinvalve.com](http://www.crispinvalve.com); or equal, having following essential characteristics:
    - a) AWWA C512.
    - b) Air release orifice size: 1/16-inch, minimum.
    - c) Cold-water pressure rating for air valve: 300 psi, minimum.
    - d) Operating pressure for seat materials: ~~Soft~~ *Resilient* seats suitable for 0 to 300 psi.
    - e) Cold-water pressure rating for body: 300 psi, minimum
    - f) Actuated by a float or floats.
- g. 2-inch air valve on Temporary Construction Water Line:
  - 1) Model UL20 manufactured by Crispin Valves, [www.crispin.com](http://www.crispin.com); or Model 200 manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com); or equal, having the following essential characteristics:
    - a) AWWA C512.
    - b) Air release orifice size: 3/16-inch, minimum

- c) Cold-water pressure rating for air valve: 150 psi, minimum.
  - d) Operating pressure for seat materials: Soft seats suitable for 0 to 25 psi.
  - e) Cold-water pressure rating for body: 150 psi, minimum.
  - f) Actuated by float or floats.
- h. 6-inch air valve on 42-inch pump discharge manifold:
- 1) Models 156S/38.5 or 256C manufactured by Val-Matic Valve and Manufacturing Corporation, [www.valmatic.com](http://www.valmatic.com); 1806/200A or 200 manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com), C62 or AL62/PL10 manufactured by Crispin Valves, [www.crispinvalve.com](http://www.crispinvalve.com); or equal, having following essential characteristics:
    - a) AWWA C512.
    - b) Air release orifice size: 3/32-inch, minimum.
    - c) Cold-water pressure rating for air valve: 300 psi, minimum
    - d) Operating pressure for seat materials: Soft seats suitable for 0 to 300 psi.
    - e) Cold-water pressure rating for body: 300 psi, minimum.
    - f) Actuated by a float or floats.
- i. High Pressure Combination Air Valves:
- 1) 4-inch air valves:
    - a) Model AVD, 1800 manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com), Model 33A manufactured by Cla-Val, [www.cla-val.com](http://www.cla-val.com); or equal, having following essential characteristics:
      - b) Cold-water pressure rating: 450 psi, minimum.
      - c) Body material: Ductile iron or cast steel.
      - d) Actuated by a float or floats.
  - 2) Size air release orifice to release entrapped air from a 17.4 cubic feet per second flow rate.
  - 3) Operating pressure for seat materials: Soft seats suitable for 0 to 450 psig.
  - 4) Flanged inlets:
    - a) Flat faced.
    - b) Mounting to ASME B16.5 steel flanges.

3. Air Release Valves:
  - a. 2-inch.
  - b. Model 45 manufactured by Val-Matic Valve and Manufacturing Corporation, [www.valmatic.com](http://www.valmatic.com), Model 200 manufactured by DeZurik/APCO, [www.dezurik.com](http://www.dezurik.com), Model PL20 manufactured by Crispin Valves, [www.crispinvalve.com](http://www.crispinvalve.com); or equal, having following essential characteristics:
  - c. AWWA C512.
  - d. Release minimum orifice size: 5/16 inch.
  - e. Cold water working pressure of 150 psi.
  - f. Releases trapped air when the pipeline is under pressure.

N. Butterfly Valves:

1. General:
  - a. AWWA C504.
  - b. Pressure classes: 150B and as specified.
  - c. Provide valves which are bubbletight at the rated pressure in either direction and suitable for operation after long periods of inactivity.
  - d. Install butterfly valves complete and lubricated in accordance with the manufacturer's instructions.
  - e. Axis of valve leaf: Horizontal when the valve is in the installed position, except where shown on the drawings.
  - f. Valve seat: Located either in the valve body mating with a stainless-steel seating surface located on the valve disc; or in the valve disc mating with a stainless-steel seating surface located in the valve body:
    - 1) No fully rubber lined bonded seat in body type seats are acceptable.
    - 2) Resilient seats shall be mechanically retained and field replaceable.
2. AWWA Class 150B butterfly valves:
  - a. AWWA C504.
  - b. Body flanges suitable for connection to AWWA Class D flanges.
3. 300 psi rated valves: Model HP350 manufactured by Henry Pratt, [www.henrypratt.com](http://www.henrypratt.com), Series 2000HP manufactured by Val-Matic Valve and Manufacturing Corp., [www.valmatic.com](http://www.valmatic.com); or equal, having the following essential characteristics:
  - a. Cold water pressure rating not less than 300 psig.
  - b. Body: Ductile iron, A536 grade 65-45-12.

- c. Shaft: Stainless-steel.
  - d. On center or eccentric shaft.
  - e. Flanged end connections:
    - 1) Flat faced.
    - 2) Body flanges suitable for connection to AWWA Class F flanges.
4. High performance butterfly valves:
- a. BHP High Performance, [www.dezurik.com](http://www.dezurik.com), Pratt HP series High Performance, [www.henrypratt.com](http://www.henrypratt.com); or equal, having the following essential characteristics:
    - 1) MSS SP-68.
    - 2) Body material: Carbon steel.
    - 3) Disc and shaft: Stainless-steel.
    - 4) Single or double offset rotation.
    - 5) Lugged style.
    - 6) Pressure class: ANSI 300.
    - 7) Provide valves which are bubbletight at the rated pressure in either direction and suitable for operation after long periods of inactivity.
    - 8) Suitable for connecting between ASME B16.5 Class 300 raised face flanges.
    - 9) Resilient seat.
    - 10) Seating surface: Stainless-steel.
5. Manual operators for butterfly valves:
- a. Equip all manually operated butterfly valves with a worm-gear or a traveling nut type manual operator.
  - b. For AWWA C504 butterfly valves:
    - 1) Worm-gear or traveling nut type manual operator in accordance with AWWA C504.
    - 2) Rim pull and component strength meets AWWA C504.
  - c. For non-AWWA butterfly valves, rim pull meets AWWA C504.
  - d. Provide gears of the self-locking type, designed to hold the valve in all positions without fluttering or creeping.
  - e. Provide operators that will open and close the valves under maximum unbalanced pressure conditions:
    - 1) AWWA C504 Class 150B butterfly valves: Design for a maximum unbalanced pressure of 150 psig.

- 2) 300 psi rated butterfly valves: Design for a maximum unbalanced pressure of 300 psig.
  - 3) High performance butterfly valves: Design for a maximum unbalanced pressure of 450 psig.
- f. Provide handwheel where shown on the drawings.
- g. Buried and submerged butterfly valves:
- 1) Suitable for buried and submerged service.
  - 2) Valve boxes.
  - 3) 2-inch square-nut operator.
  - 4) Provide extension stems where required to raise the operating nut to within 6 inches of the ground surface or the top of the concrete sump where shown on the drawings:
    - a) The extension shall not be attached with set screws; only use roll pins or bolt locking nut that extends through extension and valve shaft.
  - 5) Two 2 steel tee-handle wrenches, each with a length of 4-feet.
- h. Limit Switches:
- 1) Provide limit switches for the air chambers 12-inch isolation butterfly valves manual operator:
  - 2) Westlock AccuTrak Rotary Position Monitor mechanical limit switches, [www.westlockcontrols.com](http://www.westlockcontrols.com); or equal:
    - a) Integral part of operator and furnished with necessary gearing.
    - b) Provide with minimum of 4 independent limit switches set to function as follows:
      - i. Two electrically independent contacts – Close at fully-open position.
      - ii. Two electrically independent contacts – Open at fully-open position.
      - iii. Heavy-duty type.
      - iv. Adjustable to operate at any valve position.
      - v. Provide with A600 contact designation in accordance with NEMA ICS 5.

O. Valve Boxes:

1. Model 6855 series, manufactured by Tyler Union, [www.tylerunion.com](http://www.tylerunion.com); or equal, having the following essential characteristics:
  - a. Cast iron locking lid with pentagon shaped bolt head.

- b. Cast iron extension from valve nut operator to ground surface
  - c. Cast iron collar with lid marked "WATER".
  - d. 5 1/4-inch minimum inside diameter cast iron, composite, or PVC valve boxes for valves 4-inches in diameter and larger.
  - e. 2-piece or 3-piece and slip type.
  - f. Base and adequate extension items to extend from valve nut operator to ground surface.
2. Concrete collar flush mounted with ground surface. Refer to drawings 1695-D-60404 and 1695-D-60407.

P. Motor-Operated Ball Valves:

1. General:
  - a. Provide valves which are bubbletight at the rated pressure in either direction and suitable for operation after long periods of inactivity.
  - b. Install valves complete and lubricated in accordance with the manufacturer's instructions.
  - c. Full port.
2. Motor-Operated Trunnion mounted ball valves:
  - a. Series 4700A3 QuadroSphere bulletin 4700 manufactured by Val-Matic Valve and Manufacturing Corp., [www.valmatic.com](http://www.valmatic.com), Model DT3 manufactured by ViNtrol, Inc. [www.vintrol.com](http://www.vintrol.com); Model 370D6 series manufactured by Schlumberger/Cameron WKM, [www.products.slb.com](http://www.products.slb.com); or equal, having the following essential characteristics:
    - 1) ASME B16.5 Class 300.
    - 2) Body: Forged carbon steel, ASTM A105 or cast carbon steel ASTM A216 grade WCB.
    - 3) Shaft: Stainless-steel.
    - 4) Ball: Stainless-steel.
    - 5) On center or eccentric shaft.
    - 6) Resilient seats.
    - 7) Manufactured, inspected and tested per API 6D and ASME B16.34.
    - 8) ISO 9001 certified manufacturing facility.
    - 9) Flanged ends connect to ASME B16.5 Class 300 raised face flanges.
  - b. Provide valves which suitable for operation after long periods of inactivity.

- c. Mark the valve body with a flow arrow which indicates the manufacturer's recommended flow direction through the valve.
  - d. Suitable for exposed service.
3. Operating conditions:
- a. Valve will open and close under unbalanced conditions.
  - b. Valves are to function as pump discharge valves.
  - c. Located immediately downstream of the pumps.
  - d. Maximum pump shut-off inlet pressure:
    - 1) Pumping Plant No's 4 and No. 7: 450 psig.
  - e. Flow velocity through a fully opened valve: Between 10 feet per second and 14 feet per second.
- Q. Motor-Operated Butterfly Valves:
- 1. 300 psi rated valves: Model HP350 manufactured by Henry Pratt, [www.henrypratt.com](http://www.henrypratt.com), Series 2000HP manufactured by Val-Matic Valve and Manufacturing Corp., [www.valmatic.com](http://www.valmatic.com); or equal, having the following essential characteristics:
    - a. Cold water pressure rating not less than 300 psig.
    - b. Body: Ductile iron, A536 grade 65-45-12.
    - c. Shaft: Stainless-steel.
    - d. On center or eccentric shaft.
    - e. Flanged end connections:
      - 1) Flat faced.
      - 2) Body flanges suitable for connection to AWWA Class F flanges.
  - 2. Provide valves which are suitable for operation with flow in either direction.
  - 3. Mark valve body with flow arrow which indicates manufacturer's recommended flow direction through the valve.
  - 4. Suitable for exposed service.
- R. Motor-Operators:
- 1. Manufactured by, AUMA Actuators, Inc., [www.auma.com](http://www.auma.com), Rotork Controls, [www.rotork.com](http://www.rotork.com), Flowserve (Limitorque), [www.flowserve.com](http://www.flowserve.com), Emerson (EIM), [www.emerson.com](http://www.emerson.com); or equal, having the following essential characteristics:
    - a. Trunnion mounted ball valves:
      - 1) Actuators to open and close the valves under maximum unbalanced pressure conditions of:
        - a) Pumping Plant No's 4 and No. 7: 450 psig.
      - 2) Open and closing times: 80-seconds.

- b. Butterfly valves:
  - 1) Actuators to open and close the valves under maximum unbalanced pressure condition of 228 psig for Pumping Plant No. 4 valves and 251 psi for Pumping Plant No. 7 valves.
  - 2) 12-inch valve: 60-seconds.
  - 3) 16-inch valve: 80-seconds.
- c. AWWA C542.
- d. Motor-operators shall be from same manufacturer.
- e. Service: Open and close.
- f. Motor to supply at least two times the torque required to open and close the valves under maximum full differential pressure.
- g. Provide NEMA 250 4 enclosures for electrical equipment:
  - 1) Reduction gears.
  - 2) Mechanical position indicator.
  - 3) Electric motor:
    - a) Suitable for operation at provided project conditions per Section 01 14 10 – Use of Site.
  - 4) Induction type rated 480 volts, 3 phase, 60 hertz, conforming to NEMA MG 1 and designed for required service.
  - 5) Enclosure: Totally enclosed, fan cooled (TEFC).
  - 6) Minimum time rating: 15-minutes.
  - 7) Designed for full voltage starting and reversing duty.
  - 8) Locked-rotor torque: Not less than 250 percent of full-load torque.
  - 9) Insulation: Class F or H.
- h. Integral motor starter:
  - 1) Full voltage, reversing type with mechanical and electrical interlocks.
  - 2) Coils: 120 volts, 60-hertz.
  - 3) Provide with thermal overload device. Thermal protector integral with motor may be used in lieu of motor starter overload device.
  - 4) Control power transformer:
    - a) Voltage: 480- 120-volt, 60 hertz.
    - b) Provide with primary and secondary fuses.

- i. Torque switch mechanism:
  - 1) Integral part of motor operator which functions to protect valve and motor operator in opening and closing directions.
  - 2) Independently adjustable for both travel directions.
  - 3) Provide with A600 contact designation in accordance with NEMA ICS-5.
- j. Limit switches:
  - 1) Integral part of motor operator and furnished with necessary gearing.
  - 2) Provide with minimum of 4 independent limit switches set to function as follows:
    - a) Two electrically independent contacts – Close at fully-open position.
    - b) Two electrically independent contacts – Close at fully-closed position.
  - 3) Heavy-duty type.
  - 4) Adjustable to operate at any valve position.
  - 5) Provide with A600 contact designation in accordance with NEMA ICS-5.
- k. Handwheel:
  - 1) Provide a handwheel for manual operation that does not rotate during motor operation.
  - 2) Failure of the motor shall not prevent manual operation.
  - 3) Provide a declutching mechanism to engage the handwheel for manual operation.
- l. Pushbuttons:
  - 1) Momentary contact type.
  - 2) Provide for OPEN, CLOSE, and STOP functions.
  - 3) Operable from outside the enclosure.
- m. Selector switch:
  - 1) Two position type LOCAL-REMOTE.
  - 2) Operable from outside the enclosure.
- n. Provide strip space heater:
  - 1) 120 volts, 60-hertz from motor control transformer.
- o. Provide terminal blocks for terminating external cables:
  - 1) Suitable for connection to SCADA system.

- p. Mounting options:
- 1) Mount motor operators for valves with ball valve bodies.
  - 2) Axis of shafts for valves shall be orientated as recommended by Manufacturer.
- q. Digital Control Module (DCM):
- 1) Provide gate actuator with DCM to allow for remote monitoring and control of the actuator.
  - 2) Microprocessor based electronics with control software stored in non-volatile EEPROM memory.
  - 3) Watchdog timer to disconnect actuator from network and disable outputs upon microprocessor failure. Two serial communication ports, minimum.
  - 4) Built in transient and lightning protection.
  - 5) Perform self-diagnostics.
  - 6) Provide valve position feedback in the form of 0 to 100 percent of valve opening.
  - 7) Provide following status and alarms, minimum:
    - a) Valve in fully open position.
    - b) Valve in fully closed position.
    - c) Valve is moving in open direction in both electric and handwheel mode.
    - d) Valve is moving in closed direction in both electric and handwheel mode.
  - 8) Selector switch in LOCAL position.
  - 9) Selector switch in REMOTE position.
  - 10) Torque switch tripped in the OPEN direction.
  - 11) Torque switch tripped in the CLOSE direction.
  - 12) Valve is not moving on command.
  - 13) Loss of internal control voltage.
  - 14) Actuator failed self-diagnostics or general alarm
  - 15) Communication:
    - a) Communication protocol: Modbus RTU.
    - b) Communication method: Single RS-485 twisted pair, shielded wire network.

- r. Integral disconnect switches:
  - 1) Single throw switch.
  - 2) Rating: 480V, 60 A
  - 3) Equip operator handles with means for padlocking operator in either open or closed position.
  - 4) Position of disconnect switch shall be marked OPEN or CLOSED.

S. Flap Valves:

- 1. Model A2540 series as manufactured by Troy Valve, [www.penntroy.com](http://www.penntroy.com); or equal, having the following essential characteristics:
- 2. Cast iron body and cover.
- 3. Bronze seat and disc ring.
- 4. Stainless-steel hinge pin and cotter pins.
- 5. Constructed with a 10-degree offset from vertical for positive closure.
- 6. Flange to match pipe flange shown on drawings.

T. Pressure Switches: Model B series Type 400 manufactured by Ashcroft, Inc. [www.ashcroft.com](http://www.ashcroft.com); or equal, having the following essential characteristics:

- 1. Accuracy:  $\pm 1$  percent of full range.
- 2. Electrical output: DPDT.
- 3. Switch elements shall be general purpose, 1A, 24 VDC.
- 4. Actuator seal: Viton.
- 5. Wetted parts: ANSI type 316 stainless-steel.
- 6. NEMA 4 enclosure.
- 7. Pressure switches shall be field adjustable from 15 to 100 percent of nominal pressure range.
- 8. Bottom connects to 0.25-inch diameter male pipe connection.
- 9. Suction manifold pressure switches:
  - a. Nominal pressure range of -14.7 psi (30-inch of mercury) vacuum to 15 psig.
  - b. Switch will actuate when the pressure decreases and reaches the set point.
  - c. Automatically resets when the pressure exceeds the set point.
  - d. Set point shall be field set to actuate switch at the set point:
    - 1) Pumping Plant No. 4: 1 psi.
    - 2) Pumping Plant No. 7: 2 psi.

- e. Factory set points:
  - 1) Pumping Plant No. 4: 1 psi.
  - 2) Pumping Plant No. 7: 2 psi.
- 10. Discharge manifold pressure switches:
  - a. Set points for Pumping Plant No. 4 and Pumping Plant No. 7 shall be determined by contractor from actual final pump data.
  - b. Set point shall not be within the top 10 percent of full range.
  - c. Set point shall be field set to actuate switch at the set point.
  - d. Switch will actuate when the pressure increases and reaches the set point.
  - e. Automatically resets when the pressure drops from the set point.
- U. Pressure Transmitters: Rosemount Model 3051TG with type 306 manifold in-line pressure transmitter manufactured by Emerson, [www.emerson.com](http://www.emerson.com); or equal, having the following essential characteristics:
  - 1. Discharge manifold pressure transmitter shall measure pressure from 0 to 450 psig.
  - 2. Output: 4-20 milliamperes DC.
  - 3. Transmitter shall be suitable for operation on 10- to 36-volt DC external power supply.
  - 4. Adjustable offset (zero) and span.
  - 5. Accuracy: Plus, or minus 0.25 percent.
  - 6. In-line manifold (block and bleed) with vent/drain valve.
  - 7. Process connection: 1/2-inch-14 NPT female.
  - 8. Isolating diaphragm: 316L stainless-steel.
  - 9. Sensor fill: Silicone oil.
  - 10. Housing: Aluminum with 1/2-inch-14 NPT conduit entry size.
  - 11. Enclosure: Insulated NEMA Type 4X.
  - 12. Transmitter materials in contact with potable water shall be National Sanitation Foundation listed.
  - 13. Liquid Crystal Display with local operator interface shall be provided.
  - 14. Transient protection:
    - a. Protects pressure transmitter from damage due to lightning and switching surges.
    - b. Compatible with pressure transmitter output of 4 to 20 milliamperes.
    - c. Be of same manufacturer as pressure transmitter.

V. Portable Gasoline Engine Powered Hydraulic Power Unit:

1. Model GT-18 Power Unit manufactured by Stanley Hydraulic Tools, [www.stanley-hydraulic-tools.com](http://www.stanley-hydraulic-tools.com); units by E.H. Wachs, [www.ehwachs.com](http://www.ehwachs.com), units by Enerpac, [www.enerpac.com](http://www.enerpac.com); or equal, having the following essential characteristics:
  - a. Quantity: One.
  - b. Suitable for providing hydraulic fluid flow to a Pow-R Drive II portable hydraulic valve operator manufactured by E.H. Wachs, [www.ehwach.com](http://www.ehwach.com); or equal.
  - c. Delivers 5 or 8 gallons per minute at pressures up to 2000 psig.
  - d. Hydraulic pump driven by a minimum 18 horsepower gasoline engine.
  - e. Self-contained with pneumatic tires.
  - f. Hydraulic filter or filters that continuously cleans the hydraulic fluid and cleans refill fluid.
  - g. Computerized electronic throttle control.
  - h. Sealed non-spillable, no maintenance battery.
  - i. Quick connect hydraulic hoses to connect the portable gasoline engine powered hydraulic power unit to the portable hydraulic valve operator.
  - j. Sufficient length of quick connect hydraulic hoses for the portable gasoline engine powered hydraulic power unit to be ten feet away from the portable hydraulic valve operator without kinking the hoses or requiring tight bends.

W. Portable Hydraulic Valve Operator:

1. Pow-R Drive II by E.H. Wachs, [www.ehwach.com](http://www.ehwach.com); or equal, having the following essential characteristics:
  - a. Quantity: One.
  - b. Suitable for operating gate and butterfly valves from 6- to 48-inches.
  - c. Drive shall be lightweight aluminum gearbox with two stage reduction, planetary primary and bronze/steel secondary.
  - d. Hydraulic requirements shall be 8 gallons per minute at 1800 psig.
  - e. Peak torque shall be 800 foot-pounds.
  - f. Finish shall be hard chrome plating.
  - g. Hydraulic motor control shall have an adjustable torque setting valve for 0 to 800 pound-feet (lb-ft) control with torque indicating gauge, reversing valve and spring loaded self-centering automatic stop after release.

- h. Revolution counter with built-in digital display and push button reset shall be provided. Counter increments shall be 1/10 revolutions and shall automatically register in the forward and reverse directions.
- i. Glycerin filled hydraulic torque gage for 0 to 800 lb-ft measurement shall be provided.
- j. Metal components shall be shop painted with manufacturers standard coatings except for handles and accessories which shall be nickel plated.
- k. Two telescopic valve keys shall be provided with 1-inch square solid bars and with adjustable lengths from 4- to 9-feet.
- l. Two 2-inch square AWWA sockets shall be provided.
- m. Fitted, heavy duty storage case.

X. Piping and Valve Insulation Jackets:

- 1. Manufactured by ThermaXX LLC, 16 Hamilton Street, West Haven CT 06516; or equal, having the following essential characteristics:
  - a. Insulation material should be adequate to prevent freezing from generally accepted temperatures at location being installed.
  - b. Non-asbestos.
  - c. Hydrophobic.
  - d. R-value: Minimum R-10.
  - e. Removable.

Y. Air Vent Damper:

- 1. Model No. 1512, FrostSafe two-way damper manufactured by Val-Matic Valve and Manufacturing Corporation, 905 S. Riverside Drive, Elmhurst IL 60126; or equal having the following essential characteristics:
  - a. For 12-inch air vent.
  - b. Suitable for connection to an AWWA Class D flange.
  - c. Allows 2-way flow.
  - d. Minimizes thermal exchange of cold and warm air in and out of valve vault.
  - e. Allows air vent to vent at full capacity.

Z. Pressure Reducing Valves:

- 1. For sampling ports in turnout buildings.
  - a. Series LF25AUB-HP-Z3 (120 psi setting) and LF25AUB-Z3 (60 psi setting) manufactured by Watts, [www.watts.com](http://www.watts.com), Model CRD-L manufactured by Cla-Val, [www.cla-val.com](http://www.cla-val.com); or equal, having the following essential characteristics:

- 1) ASSE 1003.
- 2) Minimum 300 psi working pressure rating.
- 3) Lead-free brass or bronze.
- 4) Integral strainer.
- 5) Two pressure reducing valves in series as shown on the drawings.

AA. Automatic Ball Drip Valve:

1. Model B-1, manufactured by Viking Corporation, [www.vikingcorp.com](http://www.vikingcorp.com); or equal; having the following essential characteristics:
2. Stainless-steel spring.
3. Brass body.
4. Female threaded end with 1/2-inch NPT inlet and 1/4-inch outlet.
5. Automatic draining, ball check.
6. Cold water pressure rating: 250 psig, minimum.
7. Provide dielectric insulating union as necessary to prevent galvanic corrosion between dissimilar metals.

BB. Fire Hose Fittings:

1. Sizes and threading (male or female) as shown on the drawings.
2. Upstream connection: NPT threads.
3. Lead free.
4. Brass, bronze or aluminum.
5. Minimum 300 psi working pressure rating.

CC. Dielectric Unions:

1. Dielectrically insulates pipe and valves with dissimilar metals to prevent accelerated corrosion due to galvanic action and stray current.
2. Minimum 250 psi working pressure rating:
  - a. Series LF3003 manufactured by Watts, [www.watts.com](http://www.watts.com); or equal.
3. Minimum 300 psi working pressure rating:
  - a. Series D-3232 manufactured by Hart Industries, [www.hartindustries.com](http://www.hartindustries.com), Threaded Di-Electric Union manufactured by Penn Machined Works, [www.pennusa.com](http://www.pennusa.com); or equal.

## 2.02 CONTRACTOR SOURCE QUALITY TESTING

- A. Shop test AWWA butterfly valves and 300 psi rated butterfly valves in accordance with AWWA C504, and trunnion mounted ball valves in accordance with API 6D:

1. Leak test valves in both directions and hydrostatically test valves at manufacturer's facility or an alternate facility approved by COR.
2. Tests will be Government witnessed. Notify COR 30-days prior to valve testing.
3. Minimize number of Government trips by testing all valves from same manufacturer during same Government trip.
4. Prior to shop leakage test and in presence of Government, Contractor shall verify that when valve is fully closed, valve position indicator indicates, "CLOSED".
5. If indicator is not in closed position (exactly at closed), remove operator from valve, fully close valve, reinstall operator so that it indicates, "CLOSED".
6. Motor-operated trunnion mounted ball valve shop testing:
  - a. Leakage test in both directions accordance with API 6D. Record results.
  - b. Hydrostatic test in accordance with API 6D. Record pressures used.
  - c. Downstream position of valve shall be visible to Government inspector.
    - 1) Test Acceptance:
      - a) Spray or high velocity leakage will not be acceptable.
      - b) If valve leaks, adjustments shall be made until valve is drip tight with no leakage. Adjustments may include adjusting valve stops, seats, actuators or other components.
      - c) If valve is not drip tight, valve is unacceptable.
    - 2) After any adjustments are made, valve position indicator shall be inspected again and corrected if necessary.
  - d. Operational:
    - 1) Fully cycle, closed-open-closed, each valve at valve working pressure of 450 psi three times using motor-actuators being provided with the valves:
      - a) Flow and pressure do not need to be maintained during valve cycling, only at the initial opening of the valve.
    - 2) Measure, record and report motor amperage draw at quarter points during the opening and closing cycles.
  - e. Submit report of leakage, hydrostatic, and operational testing:
    - 1) Include pertinent observations and notable occurrences during testing.
7. Manually operated AWWA butterfly valves and motor-operated 300 psi rated butterfly valves shop testing:
  - a. Leakage test in both directions in accordance with AWWA C504. Record results.

- b. Hydrostatic test in accordance with AWWA C504. Record pressures used.
  - c. Pressure test valves and their seats for leaks with water in 100 percent closed position for a timed period of 5-minutes with pressure equal to rated design pressure. Valves shall be drip tight with no leakage.
  - d. Downstream position of valve shall be visible to Government inspector.
  - e. Test Acceptance:
    - 1) Spray or high velocity leakage will not be acceptable.
    - 2) If valve leaks, adjustments shall be made until valve is drip tight with no leakage. Adjustments may include adjusting valve stops, seats, actuators or other components.
    - 3) If valve is not drip tight (no leakage), valve is unacceptable.
  - f. After any adjustments are made, valve position indicator shall be inspected again and corrected if necessary.
8. Motor-operated 300 psi rated butterfly valves operational testing:
- a. Operational:
    - 1) Fully cycle, closed-open-closed, each valve at working pressure rating of valve (300 psi) three times using motor-actuators being provided with the valves:
      - a) Flow and pressure do not need to be maintained during valve cycling, only at initial opening of valve.
    - 2) Measure, record and report motor amperage draw at quarter points during the opening and closing cycles.
  - b. Submit report of leakage, hydrostatic, and operational testing:
    - 1) Include pertinent observations and notable occurrences during testing.
9. High performance butterfly valves shop testing: Perform hydrostatic shell leakage test. Perform hydrostatic seat closure leakage tests in both directions in accordance with MSS SP-61.
10. Check valves (tilting disc) shop testing:
- a. Valves shall be hydrostatically tested at 1.5 times their rated cold working pressure.
  - b. In accordance with manufacturer's recommendations.
11. Pilot-operated control valves shop testing:
- a. AWWA C530 seat leakage test and valve body hydrostatic test.
  - b. Manufacturers' requirements.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Dielectrically insulate between dissimilar metals:
  - 1. Provide insulating type unions at threaded valve, pipe or fitting connections between dissimilar metals.
  - 2. Provide insulating flange kits for flanges of dissimilar metals:
    - a. See Section 35 21 95 – Steel Manifold Piping for insulating flange kits.
- B. Provide a sufficient quantity of unions for removal, replacement and maintenance of valves and equipment.
- C. Install the valves and equipment to line and grade as shown on drawings.
- D. Install valves with flanged connections so that the bolt holes straddle the vertical centerline when in the installed position.
- E. Install valves and gaskets in accordance with the manufacturer's instructions.
- F. Pressure sustaining valve and flow control valve manufacturer's representative shall oversee equipment installation and testing.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Field testing:
  - 1. After each valve has been completely installed, test valve in steel manifold by opening and closing valve through full range of operation 3 times.
  - 2. Make changes or adjustments until operation is approved by COR, and valves are bubbletight and do not leak water past seats.
  - 3. Valves have zero allowable leakage with the following exceptions:
    - a. Metal seated check valves allowable leakage shall not exceed that specified in AWWA C508.

### **3.03 COATINGS**

- A. Coat valves and equipment in accordance with Section 09 96 20 – Coatings.

**END OF SECTION**

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**SECTION 46 33 00**  
**SODIUM HYPOCHLORITE FEED SYSTEM**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

A. Chlorine Disinfection System:

1. Include in lump sum price offered in Price Schedule 1 (Pumping Plant No. 4).

B. Mixer:

1. Include in lump sum price offered in Price Schedule 2 (Pumping Plant No. 7).

**1.02 REFERENCE STANDARDS**

A. ASTM International (ASTM)

- |    |               |  |
|----|---------------|--|
| 1. | ASTM D1785-15 | Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120   |
| 2. | ASTM D2464-15 | Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80   |
| 3. | ASTM D2467-15 | Standard Specification for Poly (Vinyl Chloride) Plastic Pipe Fittings, Schedule 80  |
| 4. | ASTM D2855-15 | Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets |
| 5. | ASTM D3299-10 | Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks   |
| 6. | ASTM D4097-01 | Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks   |

B. American National Standards Institute (ANSI) and Manufacturers Standardization Society (MSS)

- |    |                     |  |
|----|---------------------|--|
| 1. | ANSI/MSS SP-58-2009 | Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation |
|----|---------------------|--|

- C. American Society of Mechanical Engineers (ASME)
1. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
  2. ASME A112.4.14-2004 Manually Operated, Quarter-Turn Shutoff Valves for Use in Plumbing Systems
- D. Chlorine Institute (CI)
1. CI Pamphlet 96 Sodium Hypochlorite Manual
- E. NSF International and American National Standards Institute
1. NSF/ANSI 14 Plastics Piping System Components and Related Materials
  2. NSF/ANSI 60 Drinking Water Treatment Chemicals
  3. NSF/ANSI 61 Drinking Water System Components
- F. National Electrical Manufacturers Association (NEMA)
1. NEMA 250-2003 Enclosures for Electrical Equipment (1,000-Volts Maximum)

### 1.03 SYSTEM DESCRIPTION

- A. Pumping Plant No. 4:
1. Sodium hypochlorite (NaOCl, 12.5 percent maximum) feed system, which includes piping, tubing, valves, pumps, tanks, mixers, controls, instrumentation, and appurtenances, shall perform the following:
    - a. Withdraw as-delivered sodium hypochlorite solution from a storage tank located in the Chemical Building.
    - b. Inject as-delivered sodium hypochlorite solution (12.5 percent maximum) into Storage Tank S0501-TK-001 (approximately 1.0 million gallons (MG)) using metering pump (0.5 to 12-gallons per hour (gph)) and equipment panel located in the Chemical Building.
    - c. Provide adequate and continuous mixing of treated water and sodium hypochlorite solution in Storage Tank S0501-TK-001.
    - d. Continuously monitor Storage Tank S0501-TK-001 free chlorine residual and pH using sample line and online analyzer located in the Chemical Building, returning sample water to Storage Tank S0501-TK-001 using a pump.
    - e. Maintain an operational free chlorine residual in Storage Tank S0501-TK-001 between typical range of 0.2 and 1.0 mg/L as Cl<sub>2</sub> or as high as 4.0 mg/L as Cl<sub>2</sub>. Free chlorine concentrations could be increased to 10 to 50 mg/L as Cl<sub>2</sub> for the rare occasion of Storage Tank S0501-TK-001 shock chlorination.
    - f. Allow system control and data acquisition through SCADA.

2. Parts subject to regular contact or contact in the event of a spill (supports, panels, secondary containment) with sodium hypochlorite (12.5 percent maximum) or decay products shall be made of materials resistant to action of sodium hypochlorite or decay products at pressures and concentrations that could be encountered. Materials shall be suitable for such service in accordance with CI Pamphlet 96.

B. Pumping Plant No. 7:

1. Provide adequate and continuous mixing of treated water in Storage Tank S0601-TK-001.
2. There is no sodium hypochlorite feed system.

#### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittals.

B. RSN 46 33 00-1, Approval Drawings and Data:

1. Drawings in Government Format showing:
  - a. Process and instrumentation diagrams (P&IDs), instrumentation and power one-line diagrams to clearly identify vendor supplied equipment, interconnecting piping and valves, SCADA signals, skid- and field-mounted instruments, power requirements, and electrical connections. Include tags for process instrumentation, valves, motors, and typical flow direction.
  - b. Plan and elevation views, with section views as required to clearly identify proposed layout, interconnecting piping and valves, electrical connections, and anchorage of equipment and appurtenances, including dimensions and equipment relationship to other parts of work including clearances for maintenance and operation.
2. Commercial product data for all system components including piping, tubing, valves, pumps, tanks, mixers, controls, instrumentation, and appurtenances.
3. Detailed installation instructions and drawings showing installation details, detail dimensions, locations of connections, interconnecting piping, instrument locations, and tank orientations.

C. RSN 46 33 00-2, Check Prints:

1. Schematic and wiring diagrams for all electrical equipment as required by Section 01 33 26 – Electrical Drawings and Data.

D. RSN 46 33 00-3, Final Drawings and Data:

1. Typed and bound service manual:
  - a. Include an index.
  - b. Previously approved information submitted under RSN 46 33 00-1 Approval Drawings and Data in both booklet and .pdf form.

- c. Complete parts identification lists.
  - d. List of replacement parts recommended by manufacturer within 5-years of service.
  - e. Instructions for installing, lubricating, and maintaining system and appurtenances.
  - f. Any applicable test records or reports.
2. As-built drawings: 11- x 17-inch.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle equipment and components in accordance with manufacturer's recommendations to prevent damage.

### **1.06 QUALIFICATIONS**

- A. Provide equipment which are standard products of a manufacturer regularly used in water treatment industry.
- B. Provide sodium hypochlorite feed system that is standard in the water treatment industry and has been used in 2 or more locations.

### **1.07 SPARE PARTS**

- A. Provide the following spare parts:
  1. Sodium hypochlorite metering pump: 1.
  2. Polytetrafluoroethylene (PTFE) tubing: 200-feet.
  3. Flex-A-Prene pump tubing: 25-feet.

## **PART 2 PRODUCTS**

### **2.01 SODIUM HYPOCHLORITE STORAGE TANK**

- A. Sodium hypochlorite storage tank by Design Tanks, 612 West Blackhawk Street, Sioux Falls, South Dakota, 57104, or equal, with the following essential characteristics:
  1. ASTM D3299 or ASTM D4097.
  2. Purpose: Bulk liquid sodium hypochlorite storage inside the Chemical Building.
  3. Solution: Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
  4. Material:
    - a. Tank: Fiberglass Reinforced Plastic (FRP) with ultraviolet light inhibitor coating.
    - b. Gaskets: Viton.

- c. Hardware: 316 stainless steel (SS) with anti-seize applied to threaded items as applicable.
5. Number of tanks: 1.
6. Installation:
- a. Anchored to concrete housekeeping pad according to manufacturer recommendations and sodium hypochlorite compatibility.
  - b. Integrally molded lifting lugs on top or side of tank as required to fit through the Chemical Building removable roof cover.
7. Top of tank access: FRP ladder, safety yellow, with fall protection as required.
8. Integrally molded support tabs for FRP ladder and overflow piping as required with associated 316 SS hardware.
9. 6-inch sight strip with volumetric gradations on side of tank.
10. Dimensions:
- a. Capacity: 5,000-gallons.
  - b. Diameter: 8-feet.
  - c. Height: 16-foot, maximum.
11. Flanged connections:
- a. Integrally molded protrusions.
  - b. Sizes and orientation (angle corresponds to angle on drawing 1695-D-60473):
    - 1) Outlet: 270 degree, 2-inch, located at bottom of tank sidewall and low enough to allow tank to be fully drained by gravity.
    - 2) Spare outlet: 225 degree, 2-inch, located at bottom of tank sidewall and low enough to allow tank to be fully drained by gravity, blind flanged.
    - 3) Filling inlet: 315 degree, 3-inch, located on top of tank, with internal 3-inch schedule 80 PVC pipe to deliver sodium hypochlorite solution to within 1-foot of bottom of tank.
    - 4) Level sensor: 0 degree, 4-inch, located on top of tank, easily accessible from FRP ladder.
    - 5) Combined vent and overflow: 135 degree, 6-inch, located at top of tank sidewall.
    - 6) Manway: 315 degree, 24-inch, located on tank sidewall, 1-foot from bottom of tank to invert of manway, with molded-in handles.
    - 7) Additional spare: 45 degree, 4-inch, located on top of tank, easily accessible from FRP ladder, blind flanged.

12. Model number FMU40 ultrasonic level sensor by Endress+Hauser Inc., 2350 Endress Place, Greenwood, Indiana, 46143, or equal, with the following essential characteristics:
- a. Housing material: Aluminum, powder-coated.
  - b. Features:
    - 1) Model number FHX40 remote display by Endress+Hauser Inc., or equal, mounted outside of the Chemical Building near sodium hypochlorite tank filling port, such that it can be easily read during tank filling.
    - 2) Integrated temperature sensor for time of-flight correction.
    - 3) Linearization function for measured value output in any unit of length.
  - c. Range: 0- to 20-feet.
  - d. Resolution: 0.1-inch.
  - e. Accuracy: 0.2 percent.
  - f. Mounting: Top of tank using screw in flange accessory.
  - g. Electrical:
    - 1) Power: Loop-fed.
    - 2) Output: Programmable 4 to 20 mA HART signal linked to SCADA.

## **2.02 SODIUM HYPOCHLORITE METERING PUMP**

- A. Model number M-224-S-NGG-C2 peristaltic pump by Blue-White Industries, Ltd., 5300 Business Drive, Huntington Beach, California, 92649, or equal, with the following essential characteristics:
- 1. Purpose: Sodium hypochlorite injection into Storage Tank S0501-TK-001.
  - 2. Solution: Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
  - 3. Flow:
    - a. Maximum: 12-gph.
    - b. Minimum: 0.5-gph.
    - c. Average: 6-gph.
    - d. Total dynamic head: 35-feet.
  - 4. Anchored to wall-, floor-, or FRP grating-mounted FRP pedestal, with 316 SS hardware above spill containment volume according to manufacturer recommendations and sodium hypochlorite compatibility.

5. Operation:
  - a. Pump operation controlled by on/off signal from chlorine residual and pH analyzer.
  - b. Fail-safe programming to avert overdosing of sodium hypochlorite.
  - c. Tube failure detection system.
  - d. Turndown ratio: 200:1.
6. Electrical:
  - a. Power: 115 V/60 Hz, power cord NEMA 5/15 plug (US).
  - b. Enclosure: NEMA 4X for all control circuiting.
  - c. Communication: Modbus RTU linked to SCADA.
  - d. Backlit LCD display.

### **2.03 SODIUM HYPOCHLORITE FEED EQUIPMENT**

- A. Sodium hypochlorite feed equipment panel:
  1. Purpose: Control of sodium hypochlorite flow to Storage Tank S0501-TK-001, including pump protection from debris, pump calibration, pressure relief, pulsation dampening, pressure indication, and backpressure.
  2. Solution: Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
  3. Material: White PVC or polyethylene (PE) sheet.
  4. Size: 1/2-inch x 48-inch x 48-inch.
  5. Panel-mounted components:
    - a. NSF/ANSI 14 and 61.
    - b. Pipe size: 1/2-inch.
    - c. PVC:
      - 1) Y strainer: 1/32-inch mesh.
      - 2) Calibration column: 1,000 mL, clear.
      - 3) Pressure relief valve: 100-pounds per square inch (psi) maximum.
      - 4) Pulsation dampener: 150-psi maximum.
      - 5) Backpressure valve: 10- to 125-psi controlled pressure.
      - 6) Vented isolation ball valves.
    - d. 316 SS:
      - 1) Pressure gauge, Viton diaphragm protected, 0 to 100-psi.
      - 2) Mounting hardware.

- e. FRP:
  - 1) Panel mounting frame.
  - 2) Pipe supports and associated pipe clamps.

B. Field-mounted components:

1. Purpose: Delivery of sodium hypochlorite flow to Storage Tank S0501-TK-001 or sodium hypochlorite storage tank.
2. Solution: Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
3. Components:
  - a. NSF/ANSI 14 and 61.
  - b. Schedule 80 PVC piping.
  - c. PTFE tubing.
  - d. Schedule 80 PVC isolation ball valves.
  - e. Schedule 80 PVC check valves.

## 2.04 TREATED WATER STORAGE TANK MIXER

A. Model number PWM400 tank mixer by PAX Water Technologies, 860 Harbour Way South, Richmond, CA, 94804, or equal, with the following essential characteristics:

1. Purpose: Storage Tank S0501-TK-001 mixing for dispersion of sodium hypochlorite to maintain chlorine residual, water quality stability, and freeze protection.
2. Solution: treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
3. Material:
  - a. NSF/ANSI 61.
  - b. Handle and chain for deployment/removal: 316 SS.
  - c. Stand: 316 SS.
  - d. Motor seals: Nitrile butadiene rubber (NBR).
  - e. Feet: Ethylene propylene diene monomer (EPDM).
  - f. Control center: Powder-coated carbon steel, NEMA 4X enclosure.
  - g. Wiring: UL-listed submersible pump cable 14 AWG XLPE.
4. Operation:
  - a. Continuous.
  - b. Completely mixed volume: 1.0 MG.
  - c. Minimum residence time: 1-hour.
  - d. Automatic shutoff if water level drops below impeller height.

5. Electrical:
  - a. Power: Standard 120/240 VAC, 50/60 Hz.
  - b. Power switch: NEMA 4X safety disconnect switch.
  - c. Motor power: 0.5 HP.
  - d. Nominal power draw: 34-W.
  - e. Cable length: 130-feet.
6. Maintenance:
  - a. No more than once per year.
  - b. Removable by no more than two people through Storage Tank S0501-TK-001 top hatch.

## **2.05 CHLORINE RESIDUAL AND PH ANALYZER**

- A. Depolox 3 Plus Residual Analyzer with Depolox 3 Plus Flow Cell by Evoqua Water Technologies, 210 Sixth Avenue, Suite 3300, Pittsburgh, PA, 15222, or equal, with the following essential characteristics:
  1. Purpose: Free chlorine residual measurement for pacing sodium hypochlorite metering pump in addition to pH and temperature measurement.
  2. Solution: Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  3. Wetted material: NSF/ANSI 14 and 61.
  4. Flow:
    - a. Minimum: 7 gph.
    - b. Maximum: 10 gph.
    - c. Internal flow control.
  5. Inlet pressure:
    - a. Minimum: 2 psi.
    - b. Maximum: 60 psi.
  6. Connections:
    - a. 3/8-inch OD polypropylene (PP) compression fittings.
    - b. 3/8-inch OD PP compression quarter-turn valves for isolation.
  7. Free chlorine sensor: Bare-electrode.
  8. Free chlorine measurement:
    - a. Concentration range: 0 to 20 mg/L as Cl<sub>2</sub>.
    - b. Resolution: 0.01 mg/L as Cl<sub>2</sub>.
  9. Temperature measurement:
    - a. Range: 32 to 176 degrees F.
    - b. Resolution: 0.1 degrees F.

10. pH measurement:
  - a. Range: 4 to 10.
  - b. Resolution: 0.01.
11. Electrical:
  - a. Power: 115 VAC, 50/60 Hz.
  - b. Enclosure: NEMA 4X.
  - c. Controller: Internal, with ability to control sodium hypochlorite metering pump with on/off signal.
  - d. Output signal: 4 to 20 mA.
  - e. Communication: RS485 interface linked to SCADA.
  - f. Backlit LCD display.

## **2.06 CHLORINE RESIDUAL SAMPLE DRAIN TANK**

- A. Flat bottom, cylindrical, vertical tank with the following essential characteristics:
  1. Purpose: Chlorine residual sample capture for pumping back to Storage Tank S0501-TK-001.
  2. Solution: Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  3. Capacity: 80-gallons.
  4. Diameter: 2-feet.
  5. Material:
    - a. NSF/ANSI 14 and 61.
    - b. High density polyethylene (HDPE).
  6. Anchored to wall-, floor-, or FRP grating-mounted FRP pedestal, with 316 SS hardware above spill containment volume according to manufacturer recommendations and sodium hypochlorite compatibility.
  7. Connections sizes and orientation (angle corresponds to angle on drawing 1695-D-60473):
    - a. Lid: 16-inch top opening.
    - b. Inlet: 180 degree, 1-inch FNPT schedule 80 PVC bulkhead, at top of tank sidewall.
    - c. Outlet: 270 degree, 1-inch FNPT schedule 80 PVC bulkhead, at bottom of tank sidewall.
    - d. Level switch: 2-inch FNPT, on top of tank.

## 2.07 CHLORINE RESIDUAL SAMPLE RETURN PUMP

- A. Model number CRI 3-6 A-FGJ-I-V-HQQV vertical in-line centrifugal pump by Grundfos, 17100 West 118<sup>th</sup> Terrace, Olathe, Kansas, 66061, or equal, with the following essential characteristics:
1. Purpose: Chlorine residual sample return to Storage Tank S0501-TK-001 from chlorine residual sample drain tank.
  2. Solution: Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  3. Material:
    - a. Pump housing: 316 SS.
    - b. Impeller: 304 SS.
    - c. Rubber parts: Viton.
  4. Anchored to wall-, floor-, or FRP grating-mounted FRP pedestal, with 316 SS hardware above spill containment volume according to manufacturer recommendations and sodium hypochlorite compatibility.
  5. Operation:
    - a. Elevation: 5,900-feet.
    - b. Flow range: 7- to 10-gallons per minute (gpm).
    - c. Flooded suction.
    - d. Total dynamic head range: 20- to 35-feet.
    - e. Connections: 1 1/4-inch flange.
    - f. Pressure transmitter on discharge side of pump with fail-safe to prevent pump deadheading or running pump dry.
  6. Electrical:
    - a. Motor standard: NEMA.
    - b. 0.5 HP.
    - c. 1750 rpm.
    - d. 1 phase, 115/208-230 V, 60 Hz, 4-pole.
    - e. Totally enclosed fan cooled (TEFC).
  7. Tank level control:
    - a. Pump motor operation controlled by on/off signal from chlorine residual sample drain tank level switch.
    - b. Level switch:
      - 1) Model number LS-800PVC from Gems Sensors, Inc., One Cowles Road, Plainville, CT, 06062, or equal, with the following essential characteristics:
        - a) Wetted material: NSF/ANSI 14 and 61.

- b) Switch:
  - i. Normally open (NO).
  - ii. Single pull single throw (SPST).
  - iii. 20 VA.
- c) Levels:
  - i. High-high alarm, 3-inches from top of tank sidewall, or 1-inch below the inlet, whichever is lower, signal linked to SCADA.
  - ii. High level, 6-inches from top of tank sidewall, shall start chlorine residual sample return pump, signal linked to SCADA.
  - iii. Low level, 12-inches from bottom of tank sidewall, shall stop chlorine residual sample return pump, signal linked to SCADA.
  - iv. Low-low alarm, 6-inches from bottom of tank sidewall, or 1-inch above the suction pipe crown, whichever is higher, signal linked to SCADA.

## 2.08 SPILL DETECTION

- A. Liquiphant M FTL51C vibronic point level switch by Endress+Hauser Inc., 2350 Endress Place, Greenwood, Indiana, 46143, or equal, with the following essential characteristics:
  - 1. Purpose: Sodium hypochlorite or water spill detection within the Chemical Building secondary containment area.
  - 2. Solution:
    - a. Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
    - b. Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  - 3. Material:
    - a. Aluminum housing.
    - b. Sodium hypochlorite resistant coating on sensor fork.
  - 4. Electrical:
    - a. Supply voltage: 19 to 253 VAC.
    - b. Double pull double throw (DPDT).
    - c. Output signal: Up to 3.8 mA for spill signal linked to SCADA.

## 2.09 PIPING, TUBING, AND FITTINGS

- A. Plastic pipe and fittings:

1. ASTM D1785.
  2. Solution:
    - a. Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
    - b. Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  3. Material:
    - a. NSF/ANSI 14 and 61.
    - b. Schedule 80 PVC.
  4. Sizes:
    - a. 1/2-inch.
    - b. 1-inch.
    - c. 2-inch.
    - d. 3-inch.
    - e. 6-inch.
  5. Connections: Flanged, threaded, or socket weld with Weld-On 724 CPVC glue by Weld-On Adhesives, Inc., 455 West Victoria Street, Compton, California, 90220, or equal.
- B. Plastic electrical conduit and fittings:
1. ASTM D1785.
  2. Solution: None, carrier pipe for PTFE tubing.
  3. Material: Schedule 40 PVC.
  4. Size: 1 1/2-inch.
  5. Connections: Socket weld.
- C. Plastic tubing and fittings:
1. Solution:
    - a. Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
    - b. Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  2. Material:
    - a. NSF/ANSI 14 and 61.
    - b. Tubing: PTFE.
    - c. Fittings: PP.
  3. Size: 3/8-inch OD x 1/4-inch ID.
  4. Connections: 3/8-inch OD compression fittings.

- D. Camlock fittings:
1. Solution: Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
  2. Material:
    - a. NSF/ANSI 14 and 61.
    - b. PP.
- E. Pipe hangers, clamps, and channel supports:
1. Unistrut by Atkore International, Inc., 16100 South Lathrop Avenue, Harvey, Illinois, 60426, or equal, with the following essential characteristics:
    - a. Material:
      - 1) Pipe hangers, clamps, and channel supports: FRP.
      - 2) Hardware: 316 SS.
    - b. Pipe sizes:
      - 1) 1/2-inch.
      - 2) 1-inch.
      - 3) 2-inch.
      - 4) 3-inch.
      - 5) 6-inch.

## 2.10 VALVES

- A. Plastic ball and ball check valves:
1. Solution:
    - a. Sodium hypochlorite, NSF/ANSI 60, 12.5 percent maximum.
    - b. Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  2. Material:
    - a. NSF/ANSI 14 and 61.
    - b. Schedule 80 PVC.
    - c. Viton or PTFE O-rings and seals.
  3. Sizes:
    - a. 1/2-inch.
    - b. 1-inch.
    - c. 2-inch.
    - d. 3-inch.
  4. True-union.
  5. Vented ball valves.

- B. Plastic quarter-turn shut off valves on chlorine residual and pH analyzer:
1. ASME A112.4.14.
  2. Solution: Treated water with concentrations of free chlorine between 0.2 and 4.0 mg/L as Cl<sub>2</sub> and pH between 5 and 10.
  3. Material:
    - a. NSF/ANSI 14 and 61.
    - b. PP.
    - c. EPDM O-Rings and seals.
  4. Connections: 3/8-inch OD compression fittings.

## **2.11 NAMEPLATES**

- A. Equipment items shall have manufacturer's name, address, type or style, model or serial number, fabrication date, tank volume (if applicable), and catalog number on a plate secured to item of equipment.

## **2.12 ELECTRICAL WORK**

- A. Electrical work shall be in accordance with Division 26 – Electrical.

# **PART 3 EXECUTION**

## **3.01 INSTALLATION**

- A. Sodium hypochlorite feed system shall be installed in accordance with accepted procedures submitted with RSN 46 33 00-1 and as indicated on drawings, unless otherwise accepted.
- B. Installation shall include furnishing required oil and grease for initial operation up to 6-months. Grades of oil and grease shall be in accordance with written recommendations of manufacturer.
- C. Install equipment as shown on the following drawings:
1. 1695-D-60473.
  2. 1695-D-60474.
  3. 1695-D-60475.
- D. Install hangers, clamps, and channel supports for exposed piping and tubing according to ANSI/MSS SP-58.
- E. Install electrical connections in accordance with Division 26 – Electrical.

### **3.02 CONTRACTOR FIELD QUALITY TESTING**

- A. Using potable water, perform operating tests to assure that sodium hypochlorite feed system operates properly in accordance with manufacturer's instructions.
- B. Test PVC pressure pipe and PTFE tubing by the following:
  - 1. Furnish testing equipment, as approved by COR, which provides observable and accurate measurements of leakage under specified conditions.
  - 2. Maximum filling velocity: 0.25-foot per second calculated based on full area of pipe.
  - 3. Expel air from piping system during filling.
  - 4. Test pressure: 150 percent of system operating pressure based on pressure as measured at lowest point on line. Maximum test pressure not to exceed 150-psi. Test pressure for some segments may be reduced, subject to COR approval.
  - 5. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
  - 6. Maintain hydrostatic test pressure continuously for 2-hours minimum.
  - 7. Maximum allowable leakage: None, as measured by pressure drop.
- C. Test treated water storage tank mixer:
  - 1. Completely fill Storage Tank S0501-TK-001 and allow time for temperature stratification with depth.
  - 2. Upon turning the mixer on, reach temperature uniformity with depth to within 1-degree C within 24-hours.
- D. If any deficiencies are revealed during any tests, such deficiencies shall be corrected, and tests shall be repeated.

### **3.03 DISINFECTION OF WATER SUPPLY LINE**

- A. Disinfect water lines per Section 22 11 10 – Plant Auxiliary Water Systems.

### **3.04 MANUFACTURER'S FIELD SERVICES**

- A. Provide services of manufacturer's representative who is experienced in installation, adjustment, and operation of equipment specified for the following:
  - 1. Supervision of installation, adjustment, and testing of equipment.
  - 2. Training of operation and maintenance personnel:
    - a. Provide 3 hard copy manuals and 3 electronic copy manuals on flash drives.
    - b. Provide materials, manuals, and field training for up to 12 designated operating staff members.

- c. Conducted by manufacturer's representative and provided for a total period of 8-hours of normal working time.
  - d. Start after system is functionally complete but prior to final acceptance tests.
  - e. Training shall cover items contained in operating and maintenance instructions.
- B. Provide operating instructions for the sodium hypochlorite feed system including control diagrams showing complete layout of entire system as follows:
- 1. Prepare typed condensed operating instructions explaining preventive maintenance procedures, methods of checking system for normal safe operation, and procedures for safely starting and stopping system.
  - 2. Laminate operating instructions and control diagram pages and place in 3-ring "D" style binder.
  - 3. Operating instructions shall be posted next to sodium hypochlorite feed system before acceptance testing of system.

**END OF SECTION**

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**SECTION 46 81 53**  
**WARNING SIGNS**

**PART 1 GENERAL**

**1.01 MEASUREMENT AND PAYMENT**

- A. Cost:
1. Include in prices offered in the Price Schedules for other items of work.

**1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittals.
- B. RSN 46 81 53-1, Approval Data:
1. Manufacturer’s product data for sign.
  2. Drawing showing location and type of sign.

**PART 2 PRODUCTS**

**2.01 WARNING SIGNS**

- A. OSHA Danger Sign:
1. Heavy Duty Aluminum:
    - a. 25 percent postconsumer content.
    - b. 25 percent recovered materials content.
  2. Minimum width: 14-inches.
  3. Minimum height: 10-inches.
  4. Sign text: “Liquid Hypo Chloride”.

**2.02 ACCESSORIES**

- A. Attachment: Manufacturers recommended installation hardware.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install in accordance with manufacturer’s instructions.
- B. Install in locations shown on drawings.

**END OF SECTION**

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**SECTION 51 00 00**  
**INFORMATION AVAILABLE TO OFFERORS**

**PART 1      GENERAL**

**1.01    ORDER OF PRECEDENCE**

- A.    In case of differences between sections in Division 51 – Information Available to Offerors and sections in other divisions of the specifications, requirements in other divisions will govern.
  
- B.    Government assumes no responsibility for deductions, interpretations, or conclusions made by Contractor based on information made available by Government, in accordance with the clause at FAR 52.236-3 “Site Investigations and Conditions Affecting the Work.”

**PART 2      PRODUCTS**

Not Used

**PART 3      EXECUTION**

Not Used

**END OF SECTION**

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**SECTION 51 00 10**  
**PERMIT APPLICATIONS**

**PART 1 GENERAL**

**1.01 PERMIT APPLICATIONS**

A. Refer to Section 01 55 20 – Traffic Control for details regarding the permit application.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used



### INSTRUCTIONS FOR COMPLETING A UTILITY PERMIT

Any installation of utility facilities on NMDOT right-of-way, or revision of existing facilities thereon, will require the prior approval of a Utility Permit. No construction will be performed on State right-of-way before the utility has received an executed permit from the Commission.

If the application is for a parallel installation, justification as to why private right-of-way may not be utilized must be furnished.

All Utility Permit applications shall consist of the **ORIGINAL** permit form, signed as an individual owner or by authorized officers of companies or municipalities.

All **ORIGINAL** Utility Permit application for installations within Catron, Cibola, McKinley and Sandoval Counties shall be submitted to: **NMDOT District Six, Traffic Permit Section, P.O. Box 2160, Milan, NM 87021.**

The permit application shall be accompanied by a plan/sketch, showing the complete proposed installation details. This plan/sketch shall show: mile post, right-of-way, access control lines and any other pertinent data required to indicate **EXACT** physical location of the proposed installation. For proposed aerial installations, the plan/sketch shall show complete dimensions of the proposed facility, including vertical clearances above roadways (typical section) all poles, anchors and other appurtenances shall be referenced to the right-of-way or the project centerline. For proposed subsurface installations, the sketch shall include a profile indicating depth of cover, physical dimensions, method and length of encasement.

Upon receipt of the approved permit, the applicant shall notify the District Six Traffic Section in writing prior to the date of starting the proposed installation and upon completion. All installations are subject to inspection by NMDOT forces.

**PLEASE COMPLETE FORMS IN BLACK INK.**

**Bill Richardson**  
Governor

**Gary L.J. Giron**  
Cabinet Secretary

**Commission**

**Jahny Cope**  
Chairman

**Jackson Gibson**  
Secretary  
District 6

**District Six Office**  
P.O. Box 2160  
Milan, NM 87021-2160  
505-285-3200

**Larry Maynard**  
Engineer  
District 6

Any application for proposed structural installations under State roadways, i.e.: manholes, tunnels, culverts, etc., shall include a detailed structural design drawing showing all physical elements of the proposed structural installation. These will require the approval of the NMDOT Bridge Engineer.

The protection of the public and handling of traffic during the construction of the facility are the responsibility of the permit applicant. At least one lane must be kept open to traffic at all times. Barricades, flagmen, signs and flares shall be provided as necessary.

Traffic control shall be in accordance with the Manual on Uniform Traffic Control Devices.

#### **AERIAL FACILITIES, PARALLEL**

If application is for a parallel installation, **justification as to why private right-of-way may not be utilized must be furnished.** Should private right-of-way be unavailable then the proposed installation of aerial utility facilities parallel to a State roadway shall be located one foot within the right-of-way line, wherever practical. Minor variations will be processed on an individual basis. In no case shall parallel facilities be permitted within access control lines at any controlled access location.

#### **AERIAL FACILITIES, CROSSING**

The proposed installation of aerial utility facilities crossing a State roadway should cross the roadway at an angle of **90 degrees**, wherever practical. Poles, anchors and other appurtenances shall be located at, near or outside of State rights-of-way. No crossing components shall obtrude upon the foreslope, shoulder or roadway surface and all vertical clearances shall conform to the relevant codes. Minor variations will be processed on an individual basis. In no case shall poles, anchors or other surface components of aerial crossings be permitted within access control lines at any controlled access location.

#### **BURIED FACILITIES, PARALLEL**

If application is for a parallel installation, **justification as to why private right-of-way may not be utilized must be furnished.** Should private right-of-way be unavailable then the proposed installation of buried utility facilities parallel to a State roadway should be located **five (5) feet** within the right-of-way line, wherever practical. Minor variations will be processed on an individual basis. In no case shall parallel facilities be permitted within access control lines at any controlled access location. All buried facilities shall be installed at a depth of **seventy-two (72) inches** or more from the surface to the top of the facility. All trenches and ditches will be backfilled and compacted by the permit applicant. All excavations outside the roadway foreslopes shall be compacted to a density equal to the surrounding undisturbed soil (Standard Compaction Test, AASHTO Method T-99 or equivalent). Parallel ditches in excess of 350 feet in length shall not remain open over twenty-four (24) hours. Wherever possible, any excavations on or near a traveled way should not remain open overnight. The permit applicant shall be responsible for the backfill and compaction of all excavations, and shall be responsible for the safety of the traveling public.

## **BURIED FACILITIES, CROSSING**

The proposed installation of buried utility facilities crossing a State roadway should cross at an angle of **ninety (90) degrees**, wherever practical. Surface components of proposed buried crossings shall be within **five (5) feet** of the right-of-way line. All buried facility crossings shall be installed at a depth of **seventy-two (72) inches** or more from the low point of the roadway to the top of the facility. Minor variations will be processed on an individual basis. In no case shall surface components of buried crossings be permitted within the access control lines at any controlled access location.

Wherever possible, installation of buried facilities crossing a State roadway shall be performed by boring or jacking under the roadway. Installation by open cut of the roadway will be permitted only where boring or jacking is not feasible. The permit applicant shall be responsible for surface restoration on open cut installations, and may be required to assume maintenance on the portion of roadway affected until the Department repaves the roadway.

All proposed buried carrier pipes crossing a State roadway shall be constructed of steel, case iron or reinforced concrete pipe and/or shall be encased in metal pipe. Each question of encasement shall be considered on any individual basis. For all controlled access locations, the encasement shall extend completely across the access control lines. For other locations the encasement shall extend from toe of slope to toe of slope.

Complicated utility requests should be discussed with the **District Six-Traffic Engineer**, prior to submission. The Traffic Engineer may be contacted at (505) 285-3220 in Milan, New Mexico.

## **RENEWAL AND REVOCATIONS**

The permit applicant shall be responsible for notifying the NMDOT of the removal of abandoned facilities. The applicant shall also be responsible for the renewal of permit upon their expiration. The construction of any facility upon State right-of-way without an executed permit, or the violation of any terms or conditions of a permit, may be just cause for the complete removal of such facilities at the sole cost of the owner thereof.

## **FORM**

Begin with the line entitled **(UNDERSIGNED)**. A home and/or business phone number for the owner or his representative is to be included on the application.

Location on the proposed utility is to be described by the **SECTION/TOWNSHIP/RANGE** and urban areas, by **BLOCK/LOT/SUB** (where applicable). In addition, a distance from a NMDOT mile marker to the centerline of the utility in rural areas must be included. In urban areas, distances from existing intersection or other stationary objects, which can be identified on highway plans, to the centerline of the utility must be included.

The review of the permit normally requires **thirty (30) days** for completion. Please allow this amount of time when planning work schedules.

**PLEASE COMPLETE ALL FORMS IN BLACK INK.**

### UTILITY APPLICATION REQUIREMENTS

The following are requirements for obtaining a Utility Permit.

1. Insurance naming the NMDOT as additionally insured. (Section 12.11)
2. Utility Companies must provide documented authorization from the agencies for installations on land controlled by the U.S. Forest Service, BLM, U.S. Military Bases, Indian Lands and other designated state lands. (Section 12.9)
3. Traffic control plans shall be submitted in accordance to the Manual on Uniform Traffic Control Devices, Part Six current edition (Section 12.9).
4. Archeological Clearance. The Department, contact Ms. Genevieve Head, Archeological Department, at 827-5513 (Section 12.6.8), may have already cleared the area in question. If the area has not been cleared the attached Environmental Scoping Review Checklist **shall** be included.
5. Provide as built plans within thirty (30) days of project completion (Section 12.7.2).

### **OBTAINING ARCHEOLOGICAL CLEARANCE**

1. Locate your project on a location map. Include section, township and range on the map. The map should be suitable for comparison with a U.S.G.S. 7.5' quad map. Sufficient landmarks shall be included on the map so that the project location can be located in the Environmental Section.
2. Write a description of your project and include it with the map. The description should include dimensions (length and width), and the nature of the project.

EXAMPLE: "{Company} will install a buried cable in the {State Route} right-of-way. The installation will start at the junction of NM44 & NM126 and proceed south for 528 feet. At this location, the installation will leave the right-of-way and enter private land. The trench will be three feet wide."

The Department jurisdiction is only over right-of-way, which is not adjacent to State Trust or Federal land: BLM, National Forest, BIA, etc.

3. Include your name, address, telephone, and fax number. If you do not include your fax number, the archeological clearance will be mailed to you.
4. The attached "Environmental Scoping Review" checklist shall accompany all submitted materials.

5. The New Mexico Department of Transportation contact for cultural resources on utility projects is:

NMDOT Environmental Section, **Genevieve Head**

P.O. Box 1149

Santa Fe, NM 87504

Phone: (505) 827-5513

Fax: (505) 827-6862

#### UTILITY SURVEY DATA REQUIREMENTS

The following "metadata" (data about the data) shall be submitted with each utility's as-builts and electronic file, preferably as a separate text file on the submittal media. This information is critical to the Department so as to properly archive the data, as well as to provide follow-up capability in the event problems arise with the data:

1. District Utility Permit number.
2. Name, address and phone number of the responsible Land Surveyor.
3. Date of survey completion.
4. Equipment used to conduct the survey (e.g. total station, GPS, spirit level).
5. Reference mark(s) used to tie the survey to NM State Plane Coordinate System 1983, and to North American Vertical Datum 1988.
6. Ground-to-Grid combined scale factor used.

Note that elevations **SHALL** be provided every 500', and at all break points, including high and low points.

#### UTILITY PERMIT CHECK LIST

- Insurance naming the NMDOT as additionally insured. (Section 12.11)
- Documented authorization from the agency for the installation **when** the U.S. Forest Service, BLM, U.S. Military Bases, Indian Lands and other designated state lands controls the land. (Section 12.8)
- Traffic control plans shall be submitted in accordance to the Manual on Uniform Traffic Control Devices, Part Six current edition. (Section 12.9)
- Archeological clearance. (Section 12.6.8)
- Provide as built plans within thirty (30) days of project completion. (Section 12.7.2)
- Note seeding requirements for District Six on page 19 of current regulations. (Section 12.5.2)
- Return the completed **ORIGINAL** permit package to: **NMDOT, Traffic Permit Section**  
**P.O. Box 2160**  
**Milan, NM 87021**

District Six Traffic Section

APPLICATION FOR PERMIT TO INSTALL UTILITY FACILITIES  
 WITHIN PUBLIC RIGHT OF WAY

TO: NEW MEXICO DEPARTMENT  
 OF TRANSPORTATION  
 DISTRICT SIX  
 P.O. BOX 2160  
 MILAN, NM 87021

Permit No. \_\_\_\_\_  
 \_\_\_\_\_ New Installation  
 \_\_\_\_\_ Renewal Permit  
 \_\_\_\_\_ Relocation  
 \_\_\_\_\_ Remain in Place

1. Pursuant to New Mexico Statutes Annotated, 1978 Compilation, Sections 67-8-13 and 69-8-14, the undersigned

Address: \_\_\_\_\_

herein makes application to use highway right of way to install:

Size and Type of Facility \_\_\_\_\_

in the following location: NM Project No. \_\_\_\_\_ State Road No. \_\_\_\_\_

Hwy. Station \_\_\_\_\_ to Hwy Station \_\_\_\_\_ Mile Post \_\_\_\_\_ to Mile Post \_\_\_\_\_

County Section \_\_\_\_\_, Township \_\_\_\_\_, Range \_\_\_\_\_

2. For the purpose of this application "within" shall be construed as meaning "on, over, under, across, or along".
  - a. 'Engineer' shall be construed as meaning the District Engineer of the New Mexico Department of Transportation or his representative.
  - b. 'Applicant' shall be construed as meaning the individual, firm, corporation, association, governmental subdivision, or other organization making application, or the successors of any of the above.
  - c. Facility' shall be construed as meaning, but not limited to, and publicly, privately, cooperatively, municipally or governmentally owned facility used for carriage, distribution or transmission of water, gas or electricity, oil and products derived therefrom, sewage, steam or other projects carried by means of pipelines, conduits, wires, culverts, ditches, conveyors or other methods.
  - d. If application is for a parallel installation, justification as to why private right of way may not be utilized must be furnished.
3. Applicant proposes to relocate, install or leave facility \_\_\_\_\_ feet within the \_\_\_\_\_ right-of-way line. The proposed installation shall be:

- |   |                          |                                   |
|---|--------------------------|-----------------------------------|
| (Crossing or Parallel)  | (Subsurface or Overhead) | (Boring, Jacking or Pavement Cut) |
| <ol style="list-style-type: none"> <li>a. If applicant requests installation by pavement cut, complete justification therefore shall be submitted by attachment.</li> <li>b. Where application for pavement cut is justified, the application may be held in abeyance pending receipt of cash bond in an amount to be fixed by the Engineer.</li> </ol> |                          |                                   |

4. There is attached hereto a diagrammatic dimensioned drawing showing the location of existing and/or proposed installation referenced to roadway and right of way, right of way lines, any access control lines, distance of proposed installation above or below grade, highway stationing, identification of materials to be used and any other pertinent data. If application is for parallel installation, nature of adjacent land use shall be shown. Proposed installation on or in bridge or other structures, or for the installation of any structures, will require detailed structural drawings.
5. Applicant desires this permit to be in affect for 25 years. Permit will not be issued for a period longer than 25 years must be renewed upon expiration and the burden of timely renewal is on the Applicant. The Applicant shall formally notify the Engineer of actual commencement and completion of construction of the installation. The Applicant shall also formally notify the Engineer of removal or abandonment of the facility, or relinquishment of the permit.
6. The signing of the application by the Engineer and returning it to the Applicant shall validate this application as a permit. The granting of this permit shall not be construed as granting any easement or property right.
7. Servicing of facilities will not be permitted within the access control lines on any controlled access project. Should an emergency occur, the Applicant shall notify the Engineer and shall provide such flagmen, flashers, warning or other safety devices as required by the Engineer. All routine maintenance shall be performed from outside any access control lines.
8. The relocation or installation of facilities within public right of way shall be in strict conformance with all provisions of this application, drawing and the instructions for Utility Permits, as they may be modified by the Engineer, and no departure there from may be made without the written consent of the Engineer. All facilities shall be so placed that they will not interfere with nor endanger any roadway features nor other existing facilities. All construction of facilities shall be subject to the inspection and approval of the Engineer. All such work shall be performed so that danger, inconvenience and delay to the traveling public will be held to a minimum. Protection and handling of traffic during the installation are the responsibility of the Applicant, and must be approved by the Engineer.

District Six Traffic Section

- 9. The applicant will, except as otherwise ordered by the Engineer, restore the public right of way, and all bridges or other structures thereon or adjacent thereto which have been altered or affected by facility installation performed hereunder, in accordance with sound construction practices and the Engineer's specifications, and shall cause the work to be done in a workman like manner. If any damage is caused to the highway right of way or to any bridge, structure or improvement thereon or adjacent thereto by reason of the installation, maintenance, alteration or removal of such facilities or other appurtenances, the Applicant will reimburse the Engineer the full amount thereof promptly upon demand by the Engineer; provided, however, that the obligation imposed under this paragraph shall not apply in the event the damage resulted from causes beyond the control of the Applicant. All such facilities located within the right of way shall at all times be kept in such repair so as not to damage the highway, inconvenience or endanger the traveling public and shall be kept free from advertisement, posters and the like.
- 10. The applicant will at all times indemnify and save harmless the Engineer from any and all claims of every kind of character caused by or incident to the installation, alteration, removal or condition of these facilities in the right of way and will promptly reimburse the Engineer for any and all expenses incurred by the Engineer in resisting any such claim or claims. Nothing herein shall be construed to mean that the Applicant hereunder will indemnify and save harmless the Engineer from any claim caused by or incident to any neglect, carelessness or breach of duty on the part of the Engineer.
- 11. Should the Applicant at any time fail to promptly and fully perform any of the obligations imposed hereby and after thirty (30) days written notice thereof, the Engineer may at his option (a) cause the obligations to be fully carried out and performed, and the Applicant will promptly reimburse the Engineer for all costs and expenses incident thereto, (b) may summarily order the removal of such facility and if the Applicant fails to comply within a reasonable time, the Engineer may direct the removal of the facility with all costs and expenses thereto to be borne by the Applicant.
- 12. If by reason of any change in the location, construction, grade or by any other matter affecting the highway upon which any facility is located because of changing traffic conditions or otherwise, it shall become advisable in the opinion of the Engineer that said facility be removed, relocated or otherwise modified, the Applicant, upon written notice from the Engineer, shall remove, relocate or modify such facility without undue delay in such manner as the Engineer may direct or approve, at the Applicant's expense and at no cost to the Engineer. All facilities located on public right of way under the dual jurisdiction of the State and a subordinate governmental entity shall comply with all applicable rules and regulations of such entity properly and lawfully in force and including but not limited to provisions of the local franchises not in conflict with the rules and regulations of the Engineer. The Engineer makes no warranty either express or implied as to the continued existence of any highway in any particular location and expressly assumes no obligation with regard to the facility upon change, vacation or abandonment of any highway portions thereof.
- 13. Neither the making of this application nor anything herein contained shall constitute a waiver on the part of the Applicant of any rights or claims had or made by some with respect to the occupancy of the streets and highways under the Constitution and Laws of the State of New Mexico, nor shall anything herein contain in anywise prejudice or impair any rights or claims existing independent of this application with respect to the construction, operation and maintenance of the applicants facilities in the State of New Mexico.
- 14. Each copy of the application must be signed by the Applicant as an individual owner or by any official designated to execute such documents. This application is hereby granted subject to all provisions herein and to the following special provision, changes or amendments:
  - a. All work performed on State Right-of-Way shall meet the Standard Specifications for Road and Bridge Construction (2000 Edition).
  - b. The State's right of way must be restored to it's original condition or better by the Applicant.
  - c. Traffic Control shall be in accordance with the Manual on Uniform Traffic Control Devices. (Current Edition)
  - d. The Applicant shall notify the District 6 Traffic Section at least 48 hours prior to the start and 48 hours after completion of said project.
  - e. The Special Utility Permit Provisions attached hereto as Attachment One and hereby incorporated by reference.
  - f. To the extent required by contract or law, this permit is subject to prior approval by underlying fee owner, further identified "\_\_\_\_\_"
  - g. The utility owner shall provide "as-built" horizontal and vertical utility location information, **within thirty (30) days of completion of the project**, in hard copy and electronic file in AUTOCAD DWG (3D) OR MICROSTATION DGN (3D) format. The standard horizontal datum shall be North American Datum 1983 (NAD 83) and standard projections shall be the New Mexico State Plane Coordinate System 1983 (NMSPCS83). The standard vertical datum shall be North American Vertical Datum 1988 (NAVD88). The preferred media in which this data must be submitted is CD ROM; 3.5" diskette may be used for the data submittal. The utility location information shall be tied to Departmental monuments and referenced to highway mileposts or to highway project construction stationing, and certified by a New Mexico Registered Land Surveyor. Metadata or "data about the data" shall be submitted with each utility's as-built electronic file, preferably as a separate text file on the electronic submittal media, and shall include: 1.) District Utility Permit Number. 2.) Name, address and phone number of the responsible land surveyor. 3.) Date of completion of survey. 4.) Equipment used to conduct the survey. 5.) Horizontal and vertical control marks used to tie the survey to the NMSPC83 and NAVD88. 6.) Ground to Grid combined scale factor used. 7.) Elevations shall be provided every 500 feet and at all survey break points, including all high and low points

Applicant \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Title \_\_\_\_\_

Approval of this permit is hereby given this \_\_\_\_\_ day of \_\_\_\_\_ 20 \_\_\_\_\_

NEW MEXICO DEPARTMENT OF TRANSPORTATION

By: \_\_\_\_\_  
District Engineer

END OF SECTION

**SECTION 51 00 20**  
**I/O POINTS LIST**

**PART 1      GENERAL**

**1.01    PROJECT CONDITIONS**

- A.    Where there are differences as determined by CO between details shown on drawings and details of existing features at jobsite, use details of existing features at jobsite.

**1.02    INPUT/OUTPUT LIST**

- A.    Lists are solely for information of Contractor.
- B.    Government assumes no responsibility for deductions, interpretations, or conclusions made by Contractor based on information made available by Government, in accordance with the clause at FAR 52.236-3, Site Investigations and Conditions Affecting the Work.
- C.    I/O points may change throughout Contractor system design period.
- D.    Provide a minimum of 20 percent fully implemented spare for each I/O point type.
- E.    Contractor to update I/O Points Lists with information for “Data Point Identifier” and “Data Point Address” columns as per RSN 25 00 01-10, Approval Data – Final Drawings and Documentation. Hand-written entries are not acceptable. Government will provide “editable” version of these lists for which Contractor will type in required information.

### 1.03 LISTS

#### A. Pumping Plant No. 4 Discrete and Analog I/O List:

Table 51 00 20A – Pumping Plant No. 4 I/O List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
1	S0501-PIT-101	Tank S0501-TK-T001 Pressure			Analog	Input
2	S0501-ZSC-101	Tank S0501-TK-T001 Hatch Open			Discrete	Input
3	S0501-PIT-201 (future)	Tank S0501-TK-T002 Pressure			Analog	Input
4	S0501-ZSC-201 (future)	Tank S0501-TK-T002 Hatch Open			Discrete	Input
5	S0502-PS-101	Pump S0502-P-U1 Suction Pressure Switch			Discrete	Input
6	S0502-PS-102	Pump S0502-P-U1 Discharge Pressure Switch			Discrete	Input
7	S0502-PS-201	Pump S0502-P-U2 Suction Pressure Switch			Discrete	Input
8	S0502-PS-202	Pump S0502-P-U2 Discharge Pressure Switch			Discrete	Input
9	S0502-PS-301	Pump S0502-P-U3 Suction Pressure Switch			Discrete	Input

Table 51 00 20A – Pumping Plant No. 4 I/O List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
10	S0502-PS-302	Pump S0502-P-U3 Discharge Pressure Switch			Discrete	Input
11	S0502-PS-401	Pump S0502-P-U4 Suction Pressure Switch			Discrete	Input
12	S0502-PS-402	Pump S0502-P-U4 Discharge Pressure Switch			Discrete	Input
13	S0502-PIT-502	S0502-Discharge Header Pressure			Analog	Input
14	S0503-LSO-501	S0503-Plant Drainage Sump, Sump Level High			Discrete	Input
15	S0503-LE-601	S0503-Plant Drainage Sump, Oil Detected			Discrete	Input
16	S0503-PIT-102	Tank S0501-TK-T001 Pressure at Sample Port			Analog	Input
17	S0503-PIT-202 (future)	Tank S0501-TK-T002 Pressure at Sample Port (future)			Analog	Input
18	S0503-ZSO-101	Air Chamber S0503- BFV-AC1-1 Isolation Valve Open			Discrete	Input

Table 51 00 20A – Pumping Plant No. 4 I/O List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
19	S0503-ZSC-101	Air Chamber S0503-BFV-AC1-1 Isolation Valve Closed			Discrete	Input
20	S0503-ZSO-201	Air Chamber S0503-BFV-AC2-1 Isolation Valve Open			Discrete	Input
21	S0503-ZSC-201	Air Chamber S0503-BFV-AC2-1 Isolation Valve Closed			Discrete	Input
22	S0503-ZSO-301	Air Chamber S0503-BFV-AC3-1 Isolation Valve Open			Discrete	Input
23	S0503-ZSC-301	Air Chamber S0503-BFV-AC3-1 Isolation Valve Closed			Discrete	Input
24	S0503-ZSO-401	Air Chamber S0503-BFV-AC4-1 Isolation Valve Open			Discrete	Input
25	S0503-ZSC-401	Air Chamber S0503-BFV-AC4-1 Isolation Valve Closed			Discrete	Input
26	S0503-LS-101	Air Chamber S0503-TK-AC1 LowLow Level			Discrete	Input

Table 51 00 20A – Pumping Plant No. 4 I/O List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
27	S0503-LS-102	Air Chamber S0503 TK-AC1 HighHigh Level			Discrete	Input
28	S0503-LS-201	Air Chamber S0503- TK-AC2 LowLow Level			Discrete	Input
29	S0503-LS-202	Air Chamber S0503- TK-AC2 HighHigh Level			Discrete	Input
30	S0503-LS-301	Air Chamber S0503- TK-AC3 LowLow Level			Discrete	Input
31	S0503-LS-302	Air Chamber S0503- TK-AC3 HighHigh Level			Discrete	Input
32	S0503-LS-401	Air Chamber S0503- TK-AC4 LowLow Level			Discrete	Input
33	S0503-LS-402	Air Chamber S0503- TK-AC4 HighHigh Level			Discrete	Input
34	S0505-CV-TO-14	Turnout Building S0505-FCV-TO-14 Close			Discrete	Output

Table 51 00 20A – Pumping Plant No. 4 I/O List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
35	S0505-CV-TO-14	Turnout Building S0505-FCV-TO-14 Closed			Discrete	Input
36	S0505-LSO-003	S0505-Turnout Building Sump Level High			Discrete	Input
37	SCADA Cabinet	SCADA Cabinet Door Open			Discrete	Input
38	Access Control System	Access Control System Intrusion Alarm			Discrete	Input
39	PP4 Plant	Fire System Trouble			Discrete	Input
40	PP4 Plant	Fire Alarm			Discrete	Input
41	PP4 Plant	Pumping Plant Building Ambient Temperature			RTD	Input
42	PP4 Chemical Building	Chemical Building Ambient Temperature			RTD	Input
43	Diesel Fuel Oil Tank	Diesel Fuel Oil Tank Level			Analog	Input

## B. Pumping Plant No. 4 Digital Communication Protocol Point list:

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
1	S0501-UC-101	Mixer S0501-M-001 Motor Alarm			Modbus	Input
2	S0501-UC-201 (future)	Mixer S0501-M-002 Motor Alarm			Modbus	Input
3	S0502-URS-101	Pump S0502-P-U1 Start			Modbus	Output
4	S0502-URS-101	Pump S0502-P-U1 Stop			Modbus	Output
5	S0502-URS-101	Pump S0502-P-U1 Auto			Modbus	Input
6	S0502-URS-101	Pump S0502-P-U1 Interlocks Bypassed			Modbus	Input
7	S0502-URS-201	Pump S0502-P-U2 Start			Modbus	Output
8	S0502-URS-201	Pump S0502-P-U2 Stop			Modbus	Output
9	S0502-URS-201	Pump 1S0502-P-U2 Auto			Modbus	Input
10	S0502-URS-201	Pump S0502-P-U2 Interlocks Bypassed			Modbus	Input
11	S0502-URS-301	Pump S0502-P-U3 Start			Modbus	Output
12	S0502-URS-301	Pump S0502-P-U3 Stop			Modbus	Output
13	S0502-URS-301	Pump S0502-P-U3 Auto			Modbus	Input
14	S0502-URS-301	Pump S0502-P-U3 Interlocks Bypassed			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
15	S0502-URS-401	Pump S0502-P-U4 Start			Modbus	Output
16	S0502-URS-401	Pump S0502-P-U4 Stop			Modbus	Output
17	S0502-URS-401	Pump S0502-P-U4 Auto			Modbus	Input
18	S0502-URS-401	Pump S0502-P-U4 Interlocks Bypassed			Modbus	Input
19	S0502-UC-101	Pump S0502-P-U1 Running			Modbus	Input
20	S0502-UC-101	Pump S0502-P-U1 kWh			Modbus	Input
21	S0502-UC-101	Pump S0502-P-U1 Voltage			Modbus	Input
22	S0502-UC-101	Pump S0502-P-U1 Current (Amps)			Modbus	Input
23	S0502-UC-101	Pump S0502-P-U1 RTD TE101			Modbus	Input
24	S0502-UC-101	Pump S0502-P-U1 RTD TE102			Modbus	Input
25	S0502-UC-101	Pump S0502-P-U1 MPR Trip			Modbus	Input
26	S0502-UC-101	Pump S0502-P-U1 MPR Over-temperature			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
27	S0502-UC-101	Pump S0502-P-U1 MPR Relay Trouble Alarm			Modbus	Input
28	S0502-UC-101	Pump S0502-P-U1 RVSS Fault			Modbus	Input
29	S0502-UC-101	Pump S0502-P-U1 Bypass Contactor Status			Modbus	Input
30	S0502-UC-201	Pump S0502-P-U2 Running			Modbus	Input
31	S0502-UC-201	Pump S0502-P-U2 kWH			Modbus	Input
32	S0502-UC-201	Pump S0502-P-U2 Voltage			Modbus	Input
33	S0502-UC-201	Pump S0502-P-U2 Current (Amps)			Modbus	Input
34	S0502-UC-201	Pump S0502-P-U2 RTD TE101			Modbus	Input
35	S0502-UC-201	Pump S0502-P-U2 RTD TE102			Modbus	Input
36	S0502-UC-201	Pump S0502-P-U2 MPR Trip			Modbus	Input
37	S0502-UC-201	Pump S0502-P-U2 MPR Over-temperature			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
38	S0502-UC-201	Pump S0502-P-U2 MPR Relay Trouble Alarm			Modbus	Input
39	S0502-UC-201	Pump S0502-P-U2 RVSS Fault			Modbus	Input
40	S0502-UC-201	Pump S0502-P-U2 Bypass Contactor Status			Modbus	Input
41	S0502-UC-301	Pump S0502-P-U3 Running			Modbus	Input
42	S0502-UC-301	Pump S0502-P-U3 kWH			Modbus	Input
43	S0502-UC-301	Pump S0502-P-U3 Voltage			Modbus	Input
44	S0502-UC-301	Pump S0502-P-U3 Current (amps)			Modbus	Input
45	S0502-UC-301	Pump S0502-P-U3 RTD TE101			Modbus	Input
46	S0502-UC-301	Pump S0502-P-U3 RTD TE102			Modbus	Input
47	S0502-UC-301	Pump S0502-P-U3 MPR Trip			Modbus	Input
48	S0502-UC-301	Pump S0502-P-U3 MPR Over-temperature			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
49	S0502-UC-301	Pump S0502-P-U3 MPR Relay Trouble Alarm			Modbus	Input
50	S0502-UC-301	Pump S0502-P-U3 RVSS Fault			Modbus	Input
51	S0502-UC-301	Pump S0502-P-U3 Bypass Contactor Status			Modbus	Input
52	S0502-UC-401	Pump S0502-P-U4 Running			Modbus	Input
53	S0502-UC-401	Pump S0502-P-U4 kWH			Modbus	Input
54	S0502-UC-401	Pump S0502-P-U4 Voltage			Modbus	Input
55	S0502-UC-401	Pump S0502-P-U4 Current (Amps)			Modbus	Input
56	S0502-UC-401	Pump S0502-P-U4 RTD TE101			Modbus	Input
57	S0502-UC-401	Pump S0502-P-U4 RTD TE102			Modbus	Input
58	S0502-UC-401	Pump S0502-P-U4 MPR Trip			Modbus	Input
59	S0502-UC-401	Pump S0502-P-U4 MPR Over-temperature			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
60	S0502-UC-401	Pump S0502-P-U4 MPR Relay Trouble Alarm			Modbus	Input
61	S0502-UC-401	Pump S0502-P-U4 RVSS Fault			Modbus	Input
62	S0502-UC-401	Pump S0502-P-U4 Bypass Contactor Status			Modbus	Input
63	S0502-CV-U1-2	Valve S0502-MBV-U1- 2 Control			Modbus	Output
64	S0502-CV-U1-2	Valve S0502-MBV-U1- 2 Position			Modbus	Input
65	S0502-CV-U2-2	Valve S0502-MBV-U2- 2 Control			Modbus	Output
66	S0502-CV-U2-2	Valve S0502-MBV-U2- 2 Position			Modbus	Input
67	S0502-CV-U3-2	Valve S0502-MBV-U3- 2 Control			Modbus	Output
68	S0502-CV-U3-2	Valve S0502-MBV-U3- 2 Position			Modbus	Input
69	S0502-CV-U4-2	Valve S0502-MBV-U4- 2 Control			Modbus	Output
70	S0502-CV-U4-2	Valve S0502-MBV-U4- 2 Position			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
71	S0502-CV-U4-4	Valve S0502-MBFV-U4-4 Control			Modbus	Output
72	S0502-CV-U4-4	Valve S0502-MBFV-U4-4 Position			Modbus	Input
73	S0502-CV-U4-5	Valve S0502-MBFV-U4-5 Control			Modbus	Output
74	S0502-CV-U4-5	Valve S0502-MBFV-U4-5 Position			Modbus	Input
75	S0502-CV-U4-7	Valve S0502-MBFV-U4-7 Control			Modbus	Output
76	S0502-CV-U4-7	Valve S0502-MBFV-U4-7 Position			Modbus	Input
77	S0502-FIT-101	Flow Meter S0502-FIT-101 Flow			Modbus	Input
78	S0502-FIT-101	Flow Meter S0502-FIT-101 Flow Direction			Modbus	Input
79	S0502-FIT-101	Flow Meter S0502-FIT-101 Flow Totalizer			Modbus	Input
80	S0502-FIT-201	Flow Meter S0502-FIT-201 Flow			Modbus	Input
81	S0502-FIT-201	Flow Meter S0502-FIT-201 Flow Direction			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
82	S0502-FIT-201	Flow Meter S0502-FIT-201 Flow Totalizer			Modbus	Input
83	S0502-FIT-301	Flow Meter S0502-FIT-301 Flow			Modbus	Input
84	S0502-FIT-301	Flow Meter S0502-FIT-301 Flow Direction			Modbus	Input
85	S0502-FIT-301	Flow Meter S0502-FIT-301 Flow Totalizer			Modbus	Input
86	S0502-FIT-401	Flow Meter S0502-FIT-401 Flow			Modbus	Input
87	S0502-FIT-401	Flow Meter S0502-FIT-401 Flow Direction			Modbus	Input
88	S0502-FIT-401	Flow Meter S0502-FIT-401 Flow Totalizer			Modbus	Input
89	S0503-LC-001	Air Compressor S0503-C-101 Start			Modbus	Output
90	S0503-LC-001	Air Compressor S0503-C-101 Stop			Modbus	Output
91	S0503-LC-001	Air Compressor S0503-C-101 Running			Modbus	Input
92	S0503-LC-001	Air Compressor S0503-C-101 In Remote			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
93	S0503-LC-001	Air Compressor S0503-C-201 Start			Modbus	Input
94	S0503-LC-001	Air Compressor S0503-C-201 Stop			Modbus	Input
95	S0503-LC-001	Air Compressor S0503-C-201 Running			Modbus	Input
96	S0503-LC-001	Air Compressor S0503-C-201 In Remote			Modbus	Input
97	S0505-FIT-001	S0505-Flow Meter, Turnout Building, Sheepsprings Flow			Modbus	Input
98	S0505-FIT-001	S0505-Flow Meter, Turnout Building, Sheepsprings Flow Direction			Modbus	Input
99	S0505-FIT-001	S0505-Flow Meter, Turnout Building, Sheepsprings Flow Totalizer			Modbus	Input
100	UXA	Switchgear UXA Breaker UXA1 50/51 Trip			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
101	UXA	Switchgear UXA Breaker UXA1 50/51 Relay Trouble Alarm			Modbus	Input
102	UXA	Switchgear UXA Breaker UXA1 50/51 Current (Amps)			Modbus	Input
103	UXA	Switchgear UXA Breaker UXA2 50/51 Trip			Modbus	Input
104	UXA	Switchgear UXA Breaker UXA2 50/51 Relay Trouble Alarm			Modbus	Input
105	UXA	Switchgear UXA Breaker UXA2 50/51 Current (Amps)			Modbus	Input
106	UXA	Switchgear UXA Breaker UXA3 50/51 Trip			Modbus	Input
107	UXA	Switchgear UXA Breaker UXA3 50/51 Relay Trouble Alarm			Modbus	Input
108	UXA	Switchgear UXA Breaker UXA3 50/51 Current (Amps)			Modbus	Input

Table 51 00 20B – Pumping Plant No. 4 Digital Protocol Point List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
109	Switchboard DCA	Switchboard DCA PM2 Bus KWH			Modbus	Input
110	Switchboard DCA	Switchboard DCA PM2 Bus Voltage			Modbus	Input
111	Switchboard DCA	Switchboard DCA PM2 Bus Current (Amps)			Modbus	Input
112	Plant, Engine Generator	Automatic Transfer Switch, Normal			Modbus	Input
113	Plant, Engine Generator	Automatic Transfer Switch, Emergency			Modbus	Input
114	Plant, Engine Generator	Remote Test			Modbus	Output
115	Plant, Engine Generator	Remote Engine Start			Modbus	Output
116	Plant, Engine Generator	Transfer Inhibit			Modbus	Output
117	Plant, Engine Generator	Re-Transfer Inhibit			Modbus	Output

## C. Pumping Plant No. 4 Chemical Building Discrete and Analog I/O List:

Table 51 00 20C – Pumping Plant No. 4 Chemical Building Discrete and Analog I/O List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
1	S0504-LS-001	S0504-Chlorine Sample Drain Tank High-High Alarm			Discrete	Input
2	S0504-LS-004	S0504-Chlorine Sample Drain Tank Low-Low Alarm			Discrete	Input
3	S0504-YE-003	Chlorine Residual Sample Return Pump S0504-P-003 Running			Discrete	Input
4	S0504-PIT-001	S0504-Chlorine Residual Sample Return Pressure			Analog	Input
5	S0501-LE-004	S0504-Vault Leak Detector			Analog	Input
6	S0504-YE004	Emergency Shower Pump S0501-P-004 Running			Discrete	Input
7	S0504-LSH-002	S0504-Emergency Shower Sump Level			Discrete	Input
8	S0504-TE-002	S0504-Building Thermostat			Analog	Input
9	S0504-LE-003	S0504-Containment Basin Leak Detector			Discrete	Input

## D. Pumping Plant No. 4 Chemical Building Digital Communication Protocol Point list:

Table 51 00 20D – Pumping Plant No. 4 Chemical Building Digital Communication Protocol Point List						
Point No.	Location	Description	Data Point Identifier	Data Point Address	Protocol	Type
1	S0504-AIT-001	Tank S0501-TK-T001 Free Chlorine Level			Modbus	Input
2	S0504-AIT-001	Tank S0501-TK-T001 pH			Modbus	Input
3	S0504-AIT-002 (future)	Tank S0501-TK-T002 Free Chlorine Level (future)			Modbus	Input
4	S0504-AIT-002 (future)	Tank S0501-TK-T002 pH (future)			Modbus	Input
5	S0504-LT-001	S0504-Sodium Hypochlorite Storage Tank Level			HART	Input
6	S0504-FIC-001	Sodium Hypochlorite Metering Pump S0504- P-001 Motor Run			Modbus	Input
7	S0504-FIC-001	Sodium Hypochlorite Metering Pump S0504- P-001 Motor Speed			Modbus	Input
8	S0504-FIC-001	Sodium Hypochlorite Metering Pump S0504- P-001 Motor Alarm			Modbus	Input

Table 51 00 20D – Pumping Plant No. 4 Chemical Building Digital Communication Protocol Point List

Point No.	Location	Description	Data Point Identifier	Data Point Address	Protocol	Type
9	S0504-FIC-002 (future)	Sodium Hypochlorite Metering Pump S0504- P-002 Motor Run (future)			Modbus	Input
10	S0504-FIC-002 (future)	Sodium Hypochlorite Metering Pump S0504- P-002 Motor Speed (future)			Modbus	Input
11	S0504-FIC-002 (future)	Sodium Hypochlorite Metering Pump S0504- P-001 Motor Alarm (future)			Modbus	Input

## E. Remote Interface Point list:

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
1	Regulating Tank, Pumping Plant No. 7, Tank S0601-TK-T001	Tank S0601-TK-001 Pressure			DNP3	Input
2	Pumping Plant No. 3	Tank S0501-TK-001 Pressure			DNP3	Output
3	Pumping Plant No. 3	Tank S0501-TK-002 Pressure (future)			DNP3	Output
4	Tohlakai Pumping Plant	Tank S0501-TK-001 Pressure			DNP3	Output
5	Tohlakai Pumping Plant	Tank S0501-TK-002 Pressure (future)			DNP3	Output
6	San Juan Lateral Water Treatment Plant	SCADA System in Local			DNP3	Output
7	San Juan Lateral Water Treatment Plant	SCADA System in Remote			DNP3	Output
8	San Juan Lateral Water Treatment Plant	Tank S0501-TK-001 Pressure			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
9	San Juan Lateral Water Treatment Plant	Mixer S0501-M-001 Alarm			DNP3	Output
10	San Juan Lateral Water Treatment Plant	Tank S0501-TK-001 Pressure (future)			DNP3	Output
11	San Juan Lateral Water Treatment Plant	Mixer S0501-M-002 Alarm (future)			DNP3	Output
12	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC1 Alarm			DNP3	Output
13	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC2 Alarm			DNP3	Output
14	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC3 Alarm			DNP3	Output
15	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC4 Alarm			DNP3	Output
16	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 Suction Pressure Switch			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
17	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 Discharge Pressure Switch			DNP3	Output
18	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 Suction Pressure Switch			DNP3	Output
19	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 Discharge Pressure Switch			DNP3	Output
20	San Juan Lateral Water Treatment Plant	Pump S0502-P-U3 Suction Pressure Switch			DNP3	Output
21	San Juan Lateral Water Treatment Plant	Pump P0502—U3 Discharge Pressure Switch			DNP3	Output
22	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 Suction Pressure Switch			DNP3	Output
23	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 Discharge Pressure Switch			DNP3	Output
24	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 Auto			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
25	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 Interlocks Bypassed			DNP3	Output
26	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 RVSS Fault			DNP3	Output
27	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 Bypass Contactor Status			DNP3	Output
28	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 Running			DNP3	Output
29	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 Auto			DNP3	Output
30	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 Interlocks Bypassed			DNP3	Output
31	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 RVSS Fault			DNP3	Output
32	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 Bypass Contactor Status			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
33	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 Running			DNP3	Output
34	San Juan Lateral Water Treatment Plant	Pump S0502-P-U3 Auto			DNP3	Output
35	San Juan Lateral Water Treatment Plant	Pump S0502-P-U3 Interlocks Bypassed			DNP3	Output
36	San Juan Lateral Water Treatment Plant	Pump S0502-P-U3 RVSS Fault			DNP3	Output
37	San Juan Lateral Water Treatment Plant	Pump S0502-P-U3 Bypass Contactor Status			DNP3	Output
38	San Juan Lateral Water Treatment Plant	Pump S0502-P-U3 Running			DNP3	Output
39	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 Auto			DNP3	Output
40	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 Interlocks Bypassed			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
41	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 RVSS Fault			DNP3	Output
42	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 Bypass Contactor Status			DNP3	Output
43	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 Running			DNP3	Output
44	San Juan Lateral Water Treatment Plant	S0502 Discharge Header Pressure			DNP3	Output
45	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-101 Flow			DNP3	Output
46	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-101 Flow Direction			DNP3	Output
47	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-101 Flow Totalizer			DNP3	Output
48	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-201 Flow			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
49	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-201 Flow Direction			DNP3	Output
50	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-201 Flow Totalizer			DNP3	Output
51	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-301 Flow			DNP3	Output
52	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-301 Flow Direction			DNP3	Output
53	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-301 Flow Totalizer			DNP3	Output
54	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-401 Flow			DNP3	Output
55	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-401 Flow Direction			DNP3	Output
56	San Juan Lateral Water Treatment Plant	Flow Meter S0502-FIT-401 Flow Totalizer			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
57	San Juan Lateral Water Treatment Plant	Flow Meter S0505-FIT-001 Sheepsprings Flow			DNP3	Output
58	San Juan Lateral Water Treatment Plant	Flow Meter S0505-FIT-001 Sheepsprings Flow Direction			DNP3	Output
59	San Juan Lateral Water Treatment Plant	Flow Meter S0505-FIT-001 Sheepsprings Flow Totalizer			DNP3	Output
60	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC1 LowLow Level			DNP3	Output
61	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC1 HighHigh Level			DNP3	Output
62	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC2 LowLow Level			DNP3	Output
63	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC2 HighHigh Level			DNP3	Output
64	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC3 LowLow Level			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
65	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC3 HighHigh Level			DNP3	Output
66	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC4 LowLow Level			DNP3	Output
67	San Juan Lateral Water Treatment Plant	Air Chamber S0503-TK-AC4 HighHigh Level			DNP3	Output
68	San Juan Lateral Water Treatment Plant	SCADA Cabinet Door Open			DNP3	Output
69	San Juan Lateral Water Treatment Plant	Intrusion Alarm			DNP3	Output
70	San Juan Lateral Water Treatment Plant	Fire System Trouble			DNP3	Output
71	San Juan Lateral Water Treatment Plant	Fire Alarm			DNP3	Output
72	San Juan Lateral Water Treatment Plant	Pumping Plant Building Temperature			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
73	San Juan Lateral Water Treatment Plant	Chemical Building Temperature			DNP3	Output
74	San Juan Lateral Water Treatment Plant	Pumping Plant SCADA System Trouble			DNP3	Output
75	San Juan Lateral Water Treatment Plant	Tank S0501-TK-001 Free Chlorine Level			DNP3	Output
76	San Juan Lateral Water Treatment Plant	Tank S0501-TK-001 pH			DNP3	Output
77	San Juan Lateral Water Treatment Plant	Tank S0501-TK-002 Free Chlorine Level (future)			DNP3	Output
78	San Juan Lateral Water Treatment Plant	Tank S0501-TK-002 pH (future)			DNP3	Output
79	San Juan Lateral Water Treatment Plant	Tank S0501-TK-002 Chlorine Sample System General Alarm			DNP3	Output
80	San Juan Lateral Water Treatment Plant	Valve S0502-MBV-U1-2 Position			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
81	San Juan Lateral Water Treatment Plant	Valve S0502-MBV-U2-2 Position			DNP3	Output
82	San Juan Lateral Water Treatment Plant	Valve S0502-MBV-U3-2 Position			DNP3	Output
83	San Juan Lateral Water Treatment Plant	Valve S0502-MBV-U4-2 Position			DNP3	Output
84	San Juan Lateral Water Treatment Plant	Valve S0502-MBFV-U4-4 Control			DNP3	Output
85	San Juan Lateral Water Treatment Plant	Valve S0502-MBFV-U4-4 Position			DNP3	Output
86	San Juan Lateral Water Treatment Plant	Valve S0502-MBFV-U4-5 Control			DNP3	Output
87	San Juan Lateral Water Treatment Plant	Valve S0502-MBFV-U4-5 Position			DNP3	Output
88	San Juan Lateral Water Treatment Plant	Valve S0502-MBFV-U4-7 Control			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
89	San Juan Lateral Water Treatment Plant	Valve S0502-MBFV-U4-7 Position			DNP3	Output
90	San Juan Lateral Water Treatment Plant	Switchgear UXA Alarm			DNP3	Output
91	San Juan Lateral Water Treatment Plant	Switchboard DCA PM2 Bus KWH			DNP3	Output
92	San Juan Lateral Water Treatment Plant	Switchboard DCA PM2 Bus Voltage			DNP3	Output
93	San Juan Lateral Water Treatment Plant	Switchboard DCA PM2 Bus Current (Amps)			DNP3	Output
94	San Juan Lateral Water Treatment Plant	Switchboard DCA Alarm			DNP3	Output
95	San Juan Lateral Water Treatment Plant	4.16kV Motor Control Equipment MCE PM1 Bus KWH			DNP3	Output
96	San Juan Lateral Water Treatment Plant	4.16kV Motor Control Equipment MCE PM1 Bus Voltage			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
97	San Juan Lateral Water Treatment Plant	4.16kV Motor Control Equipment MCE PM1 Bus Current (Amps)			DNP3	Output
98	San Juan Lateral Water Treatment Plant	Pump S0502-P-U1 Alarm			DNP3	Output
99	San Juan Lateral Water Treatment Plant	Pump S0502-P-U2 Alarm			DNP3	Output
100	San Juan Lateral Water Treatment Plant	Pump S0502-P-U3 Alarm			DNP3	Output
101	San Juan Lateral Water Treatment Plant	Pump S0502-P-U4 Alarm			DNP3	Output
102	San Juan Lateral Water Treatment Plant	Automatic Transfer Switch, Normal			DNP3	Output
103	San Juan Lateral Water Treatment Plant	Automatic Transfer Switch, Emergency			DNP3	Output
104	San Juan Lateral Water Treatment Plant	Automatic Transfer Switch, Alarm			DNP3	Output

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
105	San Juan Lateral Water Treatment Plant	Emergency Generator Running			DNP3	Output
106	San Juan Lateral Water Treatment Plant	Emergency Generator Alarm			DNP3	Output
107	San Juan Lateral Water Treatment Plant	Sodium Hypochlorite Storage Tank Level			DNP3	Output
108	San Juan Lateral Water Treatment Plant	Sodium Hypochlorite Metering Pump Motor Alarm			DNP3	Output
109	San Juan Lateral Water Treatment Plant	Pumping Plant Automatic Operation			DNP3	Input
110	San Juan Lateral Water Treatment Plant	Pumping Plant Manual Operation			DNP3	Input
111	San Juan Lateral Water Treatment Plant	Start Pumping Plant Automatic Operation			DNP3	Input
112	San Juan Lateral Water Treatment Plant	Stop Pumping Plant Automatic Operation			DNP3	Input

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
113	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Start Setpoint A			DNP3	Input
114	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Stop Setpoint A			DNP3	Input
115	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Start Setpoint B			DNP3	Input
116	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Stop Setpoint B			DNP3	Input
117	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Start Setpoint C			DNP3	Input
118	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Stop Setpoint C			DNP3	Input
119	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Start Setpoint D			DNP3	Input
120	San Juan Lateral Water Treatment Plant	PP7 Tank S0601-TK-001 Level Stop Setpoint D			DNP3	Input

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
121	San Juan Lateral Water Treatment Plant	Start Pump S0502-P-U1			DNP3	Input
122	San Juan Lateral Water Treatment Plant	Stop Pump S0502-P-U1			DNP3	Input
123	San Juan Lateral Water Treatment Plant	Open Valve S0502-MBV-U1-2			DNP3	Input
124	San Juan Lateral Water Treatment Plant	Close Valve S0502-MBV-U1-2			DNP3	Input
125	San Juan Lateral Water Treatment Plant	Start Pump S0502-P-U2			DNP3	Input
126	San Juan Lateral Water Treatment Plant	Stop Pump S0502-P-U2			DNP3	Input
127	San Juan Lateral Water Treatment Plant	Open Valve S0502-MBV-U2-2			DNP3	Input
128	San Juan Lateral Water Treatment Plant	Close Valve S0502-MBV-U2-2			DNP3	Input

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
129	San Juan Lateral Water Treatment Plant	Start Pump S0502-P-U3			DNP3	Input
130	San Juan Lateral Water Treatment Plant	Stop Pump S0502-P-U3			DNP3	Input
131	San Juan Lateral Water Treatment Plant	Open Valve S0502-MBV-U3-2			DNP3	Input
132	San Juan Lateral Water Treatment Plant	Close Valve S0502-MBV-U3-2			DNP3	Input
133	San Juan Lateral Water Treatment Plant	Start Pump S0502-P-U4			DNP3	Input
134	San Juan Lateral Water Treatment Plant	Stop Pump S0502-P-U4			DNP3	Input
135	San Juan Lateral Water Treatment Plant	Open Valve S0502-MBV-U4-2			DNP3	Input
136	San Juan Lateral Water Treatment Plant	Close Valve S0502-MBV-U4-2			DNP3	Input

Table 51 00 20E – Pumping Plant No. 4 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
137	San Juan Lateral Water Treatment Plant	Open Valve S0502-MBFV-U4-4			DNP3	Input
138	San Juan Lateral Water Treatment Plant	Close Valve S0502-MBFV-U4-4			DNP3	Input
139	San Juan Lateral Water Treatment Plant	Open Valve S0502-MBFV-U4-5			DNP3	Input
140	San Juan Lateral Water Treatment Plant	Close Valve S0502-MBFV-U4-5			DNP3	Input
141	San Juan Lateral Water Treatment Plant	Open Valve S0502-MBFV-U4-7			DNP3	Input
142	San Juan Lateral Water Treatment Plant	Close Valve S0502-MBFV-U4-7			DNP3	Input
143	San Juan Lateral Water Treatment Plant	Close Valve S0505-FCV-TO-14			DNP3	Input
144	San Juan Lateral Water Treatment Plant	Valve S0505-FCV-TO-14 Closed			DNP3	Output

## F. Pumping Plant No. 7 Discrete and Analog I/O List:

Table 51 00 20F – Pumping Plant No. 7 Discrete and Analog I/O List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
1	S0601-PIT-101	Tank S0601-TK-001 Pressure			Analog	Input
2	S0601-ZSC-101	Tank S0601-TK-001 Hatch Open			Discrete	Input
3	S0601-PIT-201 (future)	Tank S0601-TK-002 Pressure			Analog	Input
4	S0601-ZSC-201 (future)	Tank S0601-TK-002 Hatch Open			Discrete	Input
5	S0602-PS-101	Pump S0602-P-U1 Suction Pressure Switch			Discrete	Input
6	S0602-PS-102	Pump S0602-P-U1 Discharge Pressure Switch			Discrete	Input
7	S0602-PS-201	Pump S0602-P-U2 Suction Pressure Switch			Discrete	Input
8	S0602-PS-202	Pump S0602-P-U2 Discharge Pressure Switch			Discrete	Input
9	S0602-PS-301	Pump S0602-P-U3 Suction Pressure Switch			Discrete	Input

Table 51 00 20F – Pumping Plant No. 7 Discrete and Analog I/O List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
10	S0602-PS-302	Pump S0602-P-U3 Discharge Pressure Switch			Discrete	Input
11	S0602-PS-401	Pump S0602-P-U4 Suction Pressure Switch			Discrete	Input
12	S0602-PS-402	Pump S0602-P-U4 Discharge Pressure Switch			Discrete	Input
13	S0602-PIT-502	S0602-Discharge Header Pressure			Analog	Input
14	S0603-LSO-501	S0603-Plant Drainage Sump, Sump Level High			Discrete	Input
15	S0603-LE-601	S0603-Plant Drainage Sump, Oil Detected			Discrete	Input
16	S0603-PIT-102	Tank S0601-TK-001 Pressure at Sample Port			Analog	Input
17	S0603-PIT-202 (future)	Tank S0601-TK-002 Pressure at Sample Port (future)			Analog	Input
18	S0603-ZSO-101	Air Chamber S0603-BFV-AC1-1 Isolation Valve Open			Discrete	Input

Table 51 00 20F – Pumping Plant No. 7 Discrete and Analog I/O List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
19	S0603-ZSC-101	Air Chamber S0603-BFV-AC1-1 Isolation Valve Closed			Discrete	Input
20	S0603-ZSO-201	Air Chamber S0603-BFV-AC2-1 Isolation Valve Open			Discrete	Input
21	S0603-ZSC-201	Air Chamber S0603-BFV-AC2-1 Isolation Valve Closed			Discrete	Input
22	S0603-ZSO-301	Air Chamber S0603-BFV-AC3-1 Isolation Valve Open			Discrete	Input
23	S0603-ZSC-301	Air Chamber S0603-BFV-AC3-1 Isolation Valve Closed			Discrete	Input
24	S0603-ZSO-401	Air Chamber S0603-BFV-AC4-1 Isolation Valve Open			Discrete	Input
25	S0603-ZSC-401	Air Chamber S0603-BFV-AC4-1 Isolation Valve Closed			Discrete	Input
26	S0603-LS-101	Air Chamber S0603-TK-AC1 LowLow Level			Discrete	Input

Table 51 00 20F – Pumping Plant No. 7 Discrete and Analog I/O List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
27	S0603-LS-102	Air Chamber S0603-TK-AC1 HighHigh Level			Discrete	Input
28	S0603-LS-201	Air Chamber S0603-TK-AC2 LowLow Level			Discrete	Input
29	S0603-LS-202	Air Chamber S0603-TK-AC2 HighHigh Level			Discrete	Input
30	S0603-LS-301	Air Chamber S0603-TK-AC3 LowLow Level			Discrete	Input
31	S0603-LS-302	Air Chamber S0603-TK-AC3 HighHigh Level			Discrete	Input
32	S0603-LS-401	Air Chamber S0603-TK-AC4 LowLow Level			Discrete	Input
33	S0603-LS-402	Air Chamber S0603-TK-AC4 HighHigh Level			Discrete	Input
34	S0605-CV-TO-14	Turnout Building S0605-FCV-TO-14 Close			Discrete	Output

Table 51 00 20F – Pumping Plant No. 7 Discrete and Analog I/O List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Signal	Type
35	S0605-CV-TO-14	Turnout Building S0605-FCV-TO-14 Closed			Discrete	Input
36	S0605-LSO-003	S0605-Turnout Building Sump Level High			Discrete	Input
37	SCADA Cabinet	SCADA Cabinet Door Open			Discrete	Input
38	Access Control System	Access Control System Intrusion Alarm			Discrete	Input
39	PP7 Plant	Fire System Trouble			Discrete	Input
40	PP7 Plant	Fire Alarm			Discrete	Input
41	PP7 Plant	Pumping Plant Building Temperature			RTD	Input
42	Diesel Fuel Oil Tank	Diesel Fuel Oil Tank Level			Analog	Input

## G. Pumping Plant No. 7 Digital Communication Protocol Point list:

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List						
Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
1	S0601-UC-101	Mixer S0601-M-001 Motor Alarm			Modbus	Input
2	S0601-UC-201 (future)	Mixer S0601-M-002 Motor Alarm			Modbus	Input
3	S0602-URS-101	Pump S0602-P-U1 Start			Modbus	Output
4	S0602-URS-101	Pump S0602-P-U1 Stop			Modbus	Output
5	S0602-URS-101	Pump S0602-P-U1 Auto			Modbus	Input
6	S0602-URS-101	Pump S0602-P-U1 Interlocks Bypassed			Modbus	Input
7	S0602-URS-201	Pump S0602-P-U2 Start			Modbus	Output
8	S0602-URS-201	Pump S0602-P-U2 Stop			Modbus	Output
9	S0602-URS-201	Pump S0602-P-U2 Auto			Modbus	Input
10	S0602-URS-201	Pump S0602-P-U2 Interlocks Bypassed			Modbus	Input
11	S0602-URS-301	Pump S0602-P-U3 Start			Modbus	Output
12	S0602-URS-301	Pump S0602-P-U3 Stop			Modbus	Output
13	S0602-URS-301	Pump S0602-P-U3 Auto			Modbus	Input
14	S0602-URS-301	Pump S0602-P-U3 Interlocks Bypassed			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
15	S0602-URS-401	Pump S0602-P-U4 Start			Modbus	Output
16	S0602-URS-401	Pump S0602-P-U4 Stop			Modbus	Output
17	S0602-URS-401	Pump S0602-P-U4 Auto			Modbus	Input
18	S0602-URS-401	Pump S0602-P-U4 Interlocks Bypassed			Modbus	Input
19	S0602-UC-101	Pump S0602-P-U1 Running			Modbus	Input
20	S0602-UC-101	Pump S0602-P-U1 kWh			Modbus	Input
21	S0602-UC-101	Pump S0602-P-U1 Voltage			Modbus	Input
22	S0602-UC-101	Pump S0602-P-U1 Current (Amps)			Modbus	Input
23	S0602-UC-101	Pump S0602-P-U1 RTD TE101			Modbus	Input
24	S0602-UC-101	Pump S0602-P-U1 RTD TE102			Modbus	Input
25	S0602-UC-101	Pump S0602-P-U1 MPR Trip			Modbus	Input
26	S0602-UC-101	Pump S0602-P-U1 MPR Over-temperature			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
27	S0602-UC-101	Pump S0602-P-U1 MPR Relay Trouble Alarm			Modbus	Input
28	S0602-UC-101	Pump S0602-P-U1 RVSS Fault			Modbus	Input
29	S0602-UC-101	Pump S0602-P-U1 Bypass Contactor Status			Modbus	Input
30	S0602-UC-201	Pump S0602-P-U2 Running			Modbus	Input
31	S0602-UC-201	Pump S0602-P-U2 kWH			Modbus	Input
32	S0602-UC-201	Pump S0602-P-U2 Voltage			Modbus	Input
33	S0602-UC-201	Pump S0602-P-U2 Current (Amps)			Modbus	Input
34	S0602-UC-201	Pump S0602-P-U2 RTD TE101			Modbus	Input
35	S0602-UC-201	Pump S0602-P-U2 RTD TE102			Modbus	Input
36	S0602-UC-201	Pump S0602-P-U2 MPR Trip			Modbus	Input
37	S0602-UC-201	Pump S0602-P-U2 MPR Over-temperature			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
38	S0602-UC-201	Pump S0602-P-U2 MPR Relay Trouble Alarm			Modbus	Input
39	S0602-UC-201	Pump S0602-P-U2 RVSS Fault			Modbus	Input
40	S0602-UC-201	Pump S0602-P-U2 Bypass Contactor Status			Modbus	Input
41	S0602-UC-301	Pump S0602-P-U3 Running			Modbus	Input
42	S0602-UC-301	Pump S0602-P-U3 kWH			Modbus	Input
43	S0602-UC-301	Pump S0602-P-U3 Voltage			Modbus	Input
44	S0602-UC-301	Pump S0602-P-U3 Current (Amps)			Modbus	Input
45	S0602-UC-301	Pump S0602-P-U3 RTD TE101			Modbus	Input
46	S0602-UC-301	Pump S0602-P-U3 RTD TE102			Modbus	Input
47	S0602-UC-301	Pump S0602-P-U3 MPR Trip			Modbus	Input
48	S0602-UC-301	Pump S0602-P-U3 MPR Over-temperature			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
49	S0602-UC-301	Pump S0602-P-U3 MPR Relay Trouble Alarm			Modbus	Input
50	S0602-UC-301	Pump S0602-P-U3 RVSS Fault			Modbus	Input
51	S0602-UC-301	Pump S0602-P-U3 Bypass Contactor Status			Modbus	Input
52	S0602-UC-401	Pump S0602-P-U4 Running			Modbus	Input
53	S0602-UC-401	Pump S0602-P-U4 kWH			Modbus	Input
54	S0602-UC-401	Pump S0602-P-U4 Voltage			Modbus	Input
55	S0602-UC-401	Pump S0602-P-U4 Current (Amps)			Modbus	Input
56	S0602-UC-401	Pump S0602-P-U4 RTD TE101			Modbus	Input
57	S0602-UC-401	Pump S0602-P-U4 RTD TE102			Modbus	Input
58	S0602-UC-401	Pump S0602-P-U4 MPR Trip			Modbus	Input
59	S0602-UC-401	Pump S0602-P-U4 MPR Over-temperature			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
60	S0602-UC-401	Pump S0602-P-U4 MPR Relay Trouble Alarm			Modbus	Input
61	S0602-UC-401	Pump S0602-P-U4 RVSS Fault			Modbus	Input
62	S0602-UC-401	Pump S0602-P-U4 Bypass Contactor Status			Modbus	Input
63	S0602-CV-U1-2	Valve S0602-MBV-U1- 2 Control			Modbus	Output
64	S0602-CV-U1-2	Valve S0602-MBV-U1- 2 Position			Modbus	Input
65	S0602-CV-U2-2	Valve S0602-MBV-U2- 2 Control			Modbus	Output
66	S0602-CV-U2-2	Valve S0602-MBV-U2- 2 Position			Modbus	Input
67	S0602-CV-U3-2	Valve S0602-MBV-U3- 2 Control			Modbus	Output
68	S0602-CV-U3-2	Valve S0602-MBV-U3- 2 Position			Modbus	Input
69	S0602-CV-U4-2	Valve S0602-MBV-U4- 2 Control			Modbus	Output
70	S0602-CV-U4-2	Valve S0602-MBV-U4- 2 Position			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
71	S0602-CV-U4-4	Valve S0602-MBFV-U4-4 Control			Modbus	Output
72	S0602-CV-U4-4	Valve S0602-MBFV-U4-4 Position			Modbus	Input
73	S0602-CV-U4-5	Valve S0602-MBFV-U4-5 Control			Modbus	Output
74	S0602-CV-U4-5	Valve S0602-MBFV-U4-5 Position			Modbus	Input
75	S0602-CV-U4-7	Valve S0602-MBFV-U4-7 Control			Modbus	Output
76	S0602-CV-U4-7	Valve S0602-MBFV-U4-7 Position			Modbus	Input
77	S0602-FIT-101	Flow Meter S0602-FIT-101 Flow			Modbus	Input
78	S0602-FIT-101	Flow Meter S0602-FIT-101 Flow Direction			Modbus	Input
79	S0602-FIT-101	Flow Meter S0602-FIT-101 Flow Totalizer			Modbus	Input
80	S0602-FIT-201	Flow Meter S0602-FIT-201 Flow			Modbus	Input
81	S0602-FIT-201	Flow Meter S0602-FIT-201 Flow Direction			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
82	S0602-FIT-201	Flow Meter S0602-FIT-201 Flow Totalizer			Modbus	Input
83	S0602-FIT-301	Flow Meter S0602-FIT-301 Flow			Modbus	Input
84	S0602-FIT-301	Flow Meter S0602-FIT-301 Flow Direction			Modbus	Input
85	S0602-FIT-301	Flow Meter S0602-FIT-301 Flow Totalizer			Modbus	Input
86	S0602-FIT-401	Flow Meter S0602-FIT-401 Flow			Modbus	Input
87	S0602-FIT-401	Flow Meter S0602-FIT-401 Flow Direction			Modbus	Input
88	S0602-FIT-401	Flow Meter S0602-FIT-401 Flow Totalizer			Modbus	Input
89	S0603-LC-001	Air Compressor S0603-C-101 Start			Modbus	Input
90	S0603-LC-001	Air Compressor S0603-C-101 Stop			Modbus	Input
91	S0603-LC-001	Air Compressor S0603-C-101 Running			Modbus	Input
92	S0603-LC-001	Air Compressor S0603-C-101 In Remote			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
93	S0603-LC-001	Air Compressor S0603-C-201 Start			Modbus	Input
94	S0603-LC-001	Air Compressor S0603-C-201 Stop			Modbus	Input
95	S0603-LC-001	Air Compressor S0603-C-201 Running			Modbus	Input
96	S0603-LC-001	Air Compressor S0603-C-201 In Remote			Modbus	Input
97	S0605-FIT-001	S0605-Flow Meter, Turnout Building, Tohatchi Flow			Modbus	Input
98	S0605-FIT-001	S0605-Flow Meter, Turnout Building, Tohatchi Flow Direction			Modbus	Input
99	S0605-FIT-001	S0605-Flow Meter, Turnout Building, Tohatchi Flow Totalizer			Modbus	Input
100	UXA	Switchgear UXA Breaker UXA1 50/51 Trip			Modbus	Input
101	UXA	Switchgear UXA Breaker UXA1 50/51 Relay Trouble Alarm			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
102	UXA	Switchgear UXA Breaker UXA1 50/51 Current (Amps)			Modbus	Input
103	UXA	Switchgear UXA Breaker UXA2 50/51 Trip			Modbus	Input
104	UXA	Switchgear UXA Breaker UXA2 50/51 Relay Trouble Alarm			Modbus	Input
105	UXA	Switchgear UXA Breaker UXA2 50/51 Current (Amps)			Modbus	Input
106	UXA	Switchgear UXA Breaker UXA3 50/51 Trip			Modbus	Input
107	UXA	Switchgear UXA Breaker UXA3 50/51 Relay Trouble Alarm			Modbus	Input
108	UXA	Switchgear UXA Breaker UXA3 50/51 Current (Amps)			Modbus	Input
109	Switchboard DCA	Switchboard DCA PM2 Bus KWH			Modbus	Input

Table 51 00 20G – Pumping Plant No. 7 Digital Communication Protocol Point List

Point No.	Source	Description	Data Point Identifier	Data Point Address	Protocol	Type
110	Switchboard DCA	Switchboard DCA PM2 Bus Voltage			Modbus	Input
111	Switchboard DCA	Switchboard DCA PM2 Bus Current (Amps)			Modbus	Input
112	Plant, Engine Generator	Automatic Transfer Switch, Normal			Modbus	Input
113	Plant, Engine Generator	Automatic Transfer Switch, Emergency			Modbus	Input
114	Plant, Engine Generator	Remote Test			Modbus	Output
115	Plant, Engine Generator	Remote Engine Start			Modbus	Output
116	Plant, Engine Generator	Transfer Inhibit			Modbus	Output
117	Plant, Engine Generator	Re-Transfer Inhibit			Modbus	Output

## H. Remote Interface Point list:

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
1	Regulating Tank, Tohlakai Pumping Plant, Tank 1	Tohlakai Pumping Plant Storage Tank 1 Pressure			DNP3	Input
2	Pumping Plant No. 4	Tank S0601-TK-001 Pressure			DNP3	Output
3	Pumping Plant No. 4	Tank S0601-TK-002 Pressure (future)			DNP3	Output
4	Tohlakai Pumping Plant	Tank S0601-TK-001 Pressure			DNP3	Output
5	Tohlakai Pumping Plant	Tank S0601-TK-002 Pressure (future)			DNP3	Output
6	San Juan Lateral Water Treatment Plant	SCADA System in Local			DNP3	Output
7	San Juan Lateral Water Treatment Plant	SCADA System in Remote			DNP3	Output
8	San Juan Lateral Water Treatment Plant	Tank S0601-TK-001 Pressure			DNP3	Output
9	San Juan Lateral Water Treatment Plant	Mixer S0601-M-001 Alarm			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
10	San Juan Lateral Water Treatment Plant	Tank S0601-TK-002 Pressure (future)			DNP3	Output
11	San Juan Lateral Water Treatment Plant	Mixer S0601-M-002 Alarm (future)			DNP3	Output
12	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC1 Alarm			DNP3	Output
13	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC2 Alarm			DNP3	Output
14	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC3 Alarm			DNP3	Output
15	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC4 Alarm			DNP3	Output
16	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 Suction Pressure Switch			DNP3	Output
17	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 Discharge Pressure Switch			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
18	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 Suction Pressure Switch			DNP3	Output
19	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 Discharge Pressure Switch			DNP3	Output
20	San Juan Lateral Water Treatment Plant	Pump S0602-P-U3 Suction Pressure Switch			DNP3	Output
21	San Juan Lateral Water Treatment Plant	Pump S0602-P-U3 Discharge Pressure Switch			DNP3	Output
22	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 Suction Pressure Switch			DNP3	Output
23	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 Discharge Pressure Switch			DNP3	Output
24	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 Auto			DNP3	Output
25	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 Interlocks Bypassed			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
26	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 RVSS Fault			DNP3	Output
27	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 Bypass Contactor Status			DNP3	Output
28	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 Running			DNP3	Output
29	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 Auto			DNP3	Output
30	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 Interlocks Bypassed			DNP3	Output
31	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 RVSS Fault			DNP3	Output
32	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 Bypass Contactor Status			DNP3	Output
33	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 Running			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
34	San Juan Lateral Water Treatment Plant	Pump S0602-P-U3 Auto			DNP3	Output
35	San Juan Lateral Water Treatment Plant	Pump S0603-P-U3 Interlocks Bypassed			DNP3	Output
36	San Juan Lateral Water Treatment Plant	Pump S0602-P-U3 RVSS Fault			DNP3	Output
37	San Juan Lateral Water Treatment Plant	Pump S0602-P-U3 Bypass Contactor Status			DNP3	Output
38	San Juan Lateral Water Treatment Plant	Pump S0602-P-U3 Running			DNP3	Output
39	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 Auto			DNP3	Output
40	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 Interlocks Bypassed			DNP3	Output
41	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 RVSS Fault			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
42	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 Bypass Contactor Status			DNP3	Output
43	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 Running			DNP3	Output
44	San Juan Lateral Water Treatment Plant	S0602 Discharge Header Pressure			DNP3	Output
45	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-101 Flow			DNP3	Output
46	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-101 Flow Direction			DNP3	Output
47	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-101 Flow Totalizer			DNP3	Output
48	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-201 Flow			DNP3	Output
49	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-201 Flow Direction			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
50	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-201 Flow Totalizer			DNP3	Output
51	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-301 Flow			DNP3	Output
52	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-301 Flow Direction			DNP3	Output
53	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-301 Flow Totalizer			DNP3	Output
54	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-401 Flow			DNP3	Output
55	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-401 Flow Direction			DNP3	Output
56	San Juan Lateral Water Treatment Plant	Flow Meter S0602-FIT-401 Flow Totalizer			DNP3	Output
57	San Juan Lateral Water Treatment Plant	Flow Meter S0605-FIT-001Tohatchi Flow			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
58	San Juan Lateral Water Treatment Plant	Flow Meter S0605-FIT-001 Tohatchi Flow Direction			DNP3	Output
59	San Juan Lateral Water Treatment Plant	Flow Meter S0605-FIT-001 Tohatchi Flow Totalizer			DNP3	Output
60	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC1 LowLow Level			DNP3	Output
61	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC1 HighHigh Level			DNP3	Output
62	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC2 LowLow Level			DNP3	Output
63	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC2 HighHigh Level			DNP3	Output
64	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC3 LowLow Level			DNP3	Output
65	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC3 HighHigh Level			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
66	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC4 LowLow Level			DNP3	Output
67	San Juan Lateral Water Treatment Plant	Air Chamber S0603-TK-AC4 HighHigh Level			DNP3	Output
68	San Juan Lateral Water Treatment Plant	SCADA Cabinet Door Open			DNP3	Output
69	San Juan Lateral Water Treatment Plant	Intrusion Alarm			DNP3	Output
70	San Juan Lateral Water Treatment Plant	Fire System Trouble			DNP3	Output
71	San Juan Lateral Water Treatment Plant	Fire Alarm			DNP3	Output
72	San Juan Lateral Water Treatment Plant	Pumping Plant Building Temperature			DNP3	Output
73	San Juan Lateral Water Treatment Plant	Pumping Plant SCADA System Trouble			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
74	San Juan Lateral Water Treatment Plant	Valve S0602-MBV-U1-2 Position			DNP3	Output
75	San Juan Lateral Water Treatment Plant	Valve S0602-MBV-U2-2 Position			DNP3	Output
76	San Juan Lateral Water Treatment Plant	Valve S0602-MBV-U3-2 Position			DNP3	Output
77	San Juan Lateral Water Treatment Plant	Valve S0602-MBV-U4-2 Position			DNP3	Output
78	San Juan Lateral Water Treatment Plant	Valve S0602-MBFV-U4-4 Control			DNP3	Output
79	San Juan Lateral Water Treatment Plant	Valve S0602-MBFV-U4-4 Position			DNP3	Output
80	San Juan Lateral Water Treatment Plant	Valve S0602-MBFV-U4-5 Control			DNP3	Output
81	San Juan Lateral Water Treatment Plant	Valve S0602-MBFV-U4-5 Position			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
82	San Juan Lateral Water Treatment Plant	Valve S0602-MBFV-U4-7 Control			DNP3	Output
83	San Juan Lateral Water Treatment Plant	Valve S0602-MBFV-U4-7 Position			DNP3	Output
84	San Juan Lateral Water Treatment Plant	Switchgear UXA Alarm			DNP3	Output
85	San Juan Lateral Water Treatment Plant	Switchboard DCA PM2 Bus KWH			DNP3	Output
86	San Juan Lateral Water Treatment Plant	Switchboard DCA PM2 Bus Voltage			DNP3	Output
87	San Juan Lateral Water Treatment Plant	Switchboard DCA PM2 Bus Current (Amps)			DNP3	Output
88	San Juan Lateral Water Treatment Plant	Switchboard DCA Alarm			DNP3	Output
89	San Juan Lateral Water Treatment Plant	4.16kV Motor Control Equipment MCE PM1 Bus KWH			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
90	San Juan Lateral Water Treatment Plant	4.16kV Motor Control Equipment MCE PM1 Bus Voltage			DNP3	Output
91	San Juan Lateral Water Treatment Plant	4.16kV Motor Control Equipment MCE PM1 Bus Current (Amps)			DNP3	Output
92	San Juan Lateral Water Treatment Plant	Pump S0602-P-U1 Alarm			DNP3	Output
93	San Juan Lateral Water Treatment Plant	Pump S0602-P-U2 Alarm			DNP3	Output
94	San Juan Lateral Water Treatment Plant	Pump S0602-P-U3 Alarm			DNP3	Output
95	San Juan Lateral Water Treatment Plant	Pump S0602-P-U4 Alarm			DNP3	Output
96	San Juan Lateral Water Treatment Plant	Automatic Transfer Switch, Normal			DNP3	Output
97	San Juan Lateral Water Treatment Plant	Automatic Transfer Switch, Emergency			DNP3	Output

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
98	San Juan Lateral Water Treatment Plant	Automatic Transfer Switch, Alarm			DNP3	Output
99	San Juan Lateral Water Treatment Plant	Emergency Generator Running			DNP3	Output
100	San Juan Lateral Water Treatment Plant	Emergency Generator Alarm			DNP3	Output
101	San Juan Lateral Water Treatment Plant	Pumping Plant Automatic Operation			DNP3	Input
102	San Juan Lateral Water Treatment Plant	Pumping Plant Manual Operation			DNP3	Input
103	San Juan Lateral Water Treatment Plant	Start Pumping Plant Automatic Operation			DNP3	Input
104	San Juan Lateral Water Treatment Plant	Stop Pumping Plant Automatic Operation			DNP3	Input
105	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Start Setpoint A			DNP3	Input

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
106	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Stop Setpoint A			DNP3	Input
107	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Start Setpoint B			DNP3	Input
108	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Stop Setpoint B			DNP3	Input
109	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Start Setpoint C			DNP3	Input
110	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Stop Setpoint C			DNP3	Input
111	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Start Setpoint D			DNP3	Input
112	San Juan Lateral Water Treatment Plant	Tohlakai Tank Level Stop Setpoint D			DNP3	Input
113	San Juan Lateral Water Treatment Plant	Start Pump S0602-P-U1			DNP3	Input

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
114	San Juan Lateral Water Treatment Plant	Stop Pump S0602-P-U1			DNP3	Input
115	San Juan Lateral Water Treatment Plant	Open Valve S0602-MBV-U1-2			DNP3	Input
116	San Juan Lateral Water Treatment Plant	Close Valve S0602-MBV-U1-2			DNP3	Input
117	San Juan Lateral Water Treatment Plant	Start Pump S0602-P-U2			DNP3	Input
118	San Juan Lateral Water Treatment Plant	Stop Pump S0602-P-U2			DNP3	Input
119	San Juan Lateral Water Treatment Plant	Open Valve S0602-MBV-U2-2			DNP3	Input
120	San Juan Lateral Water Treatment Plant	Close Valve S0602-MBV-U2-2			DNP3	Input
121	San Juan Lateral Water Treatment Plant	Start Pump S0602-P-U3			DNP3	Input

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List

Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
122	San Juan Lateral Water Treatment Plant	Stop Pump S0602-P-U3			DNP3	Input
123	San Juan Lateral Water Treatment Plant	Open Valve S0602-MBV-U3-2			DNP3	Input
124	San Juan Lateral Water Treatment Plant	Close Valve S0602-MBV-U3-2			DNP3	Input
125	San Juan Lateral Water Treatment Plant	Start Pump S0602-P-U4			DNP3	Input
126	San Juan Lateral Water Treatment Plant	Stop Pump S0602-P-U4			DNP3	Input
127	San Juan Lateral Water Treatment Plant	Open Valve S0602-MBV-U4-2			DNP3	Input
128	San Juan Lateral Water Treatment Plant	Close Valve S0602-MBV-U4-2			DNP3	Input
129	San Juan Lateral Water Treatment Plant	Open Valve S0602-MBFV-U4-4			DNP3	Input

Table 51 00 20H – Pumping Plant No. 7 Remote Interface Point List						
Point No.	Remote System	Description	Data Point Identifier	Data Point Address	Protocol	Type
130	San Juan Lateral Water Treatment Plant	Close Valve S0602-MBFV-U4-4			DNP3	Input
131	San Juan Lateral Water Treatment Plant	Open Valve S0602-MBFV-U4-5			DNP3	Input
132	San Juan Lateral Water Treatment Plant	Close Valve S0602-MBFV-U4-5			DNP3	Input
133	San Juan Lateral Water Treatment Plant	Open Valve S0602-MBFV-U4-7			DNP3	Input
134	San Juan Lateral Water Treatment Plant	Close Valve S0602-MBFV-U4-7			DNP3	Input
135	San Juan Lateral Water Treatment Plant	Close Valve S0605-FCV-TO-14			DNP3	Input
136	San Juan Lateral Water Treatment Plant	Valve S0605-FCV-TO-14 Closed			DNP3	Output

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 51 00 25**  
**PUMP CONTROL AND SEQUENCING LOGIC**

**PART 1      GENERAL**

**1.01    PROJECT CONDITIONS**

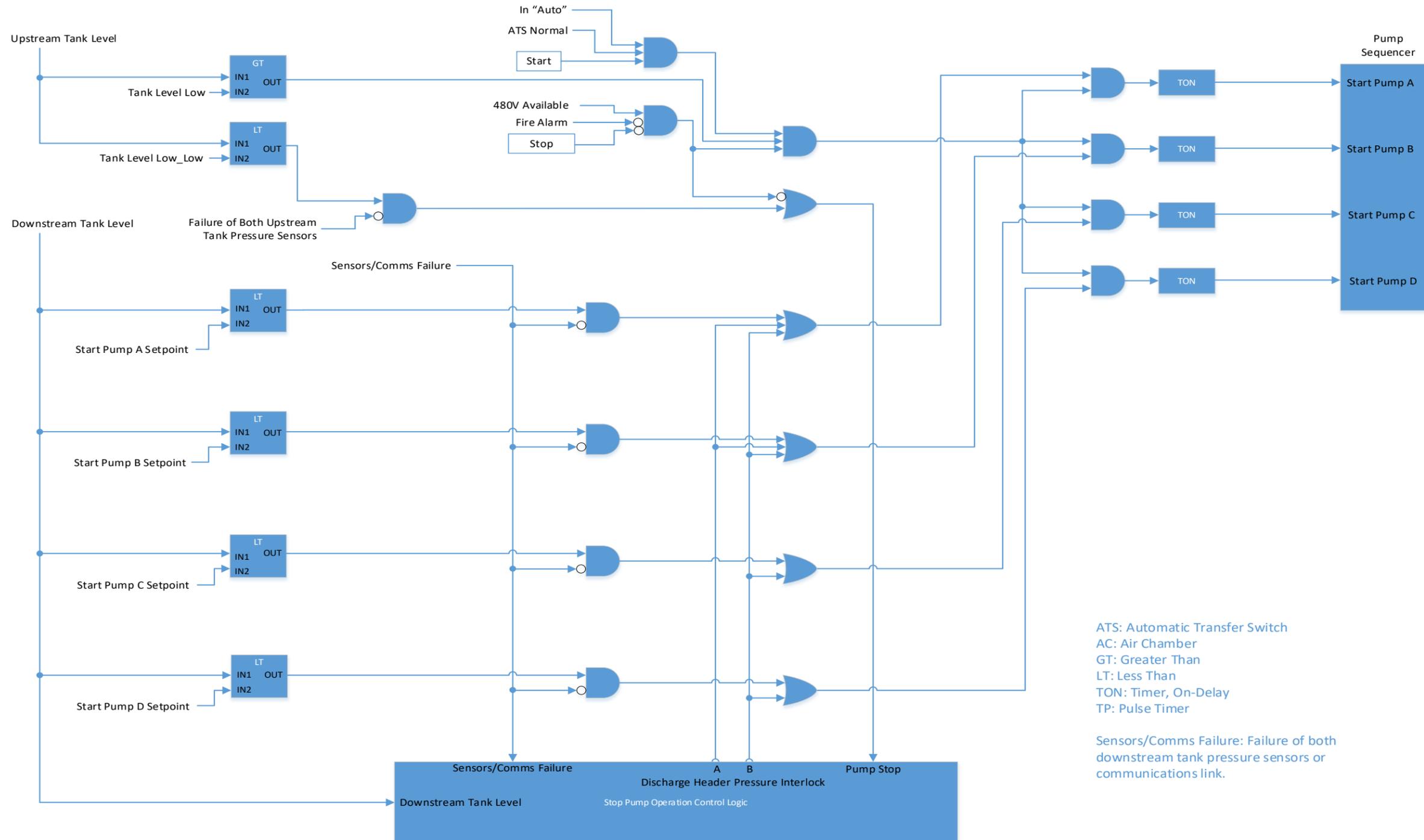
- A.    Where there are differences as determined by CO between details shown on diagrams and details of existing features at jobsite, use details of existing features at jobsite.

**1.02    PUMP CONTROL AND SEQUENCE LOGIC**

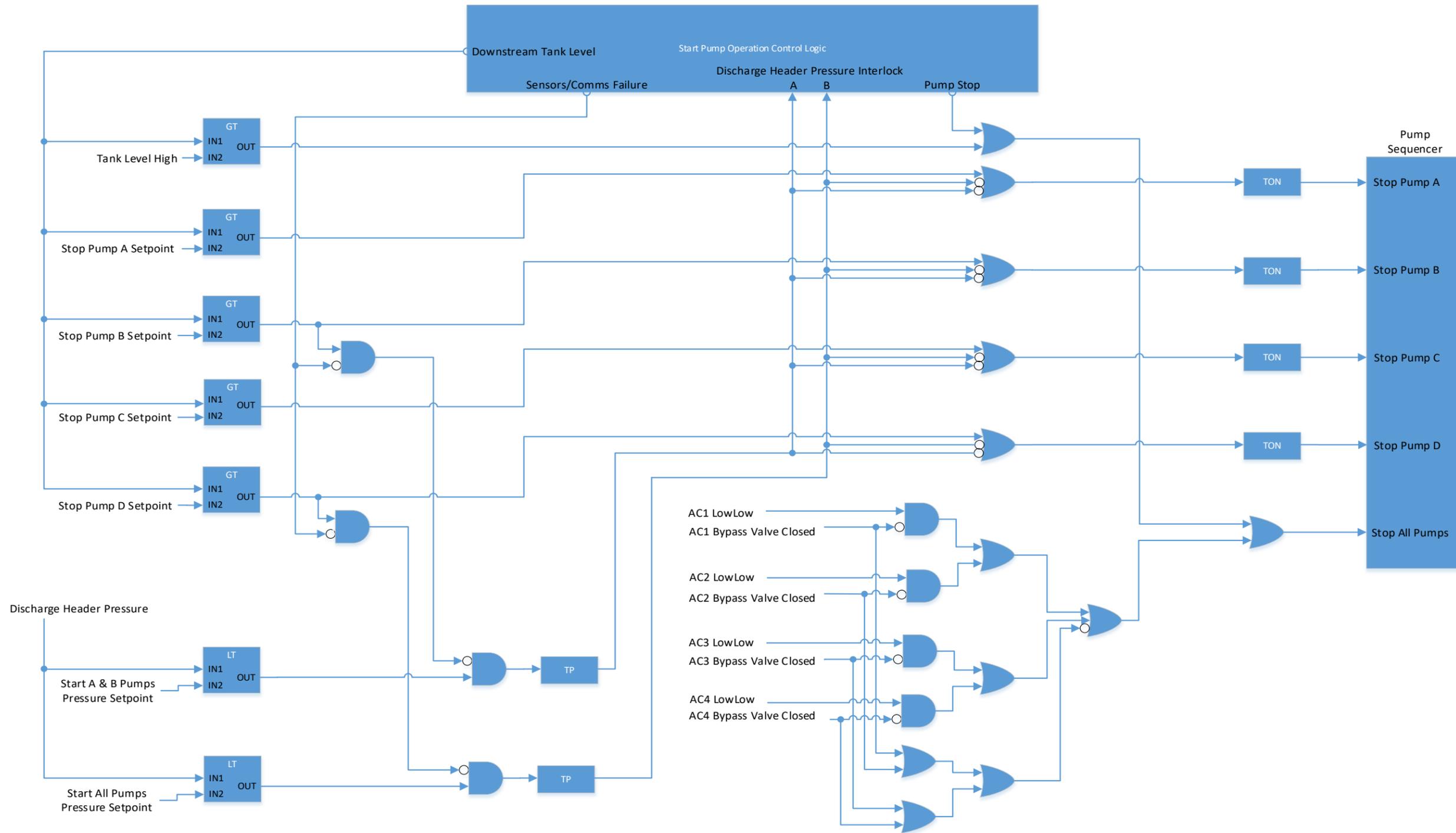
- A.    Logic diagrams are solely for information of Contractor.
- B.    Government assumes no responsibility for deductions, interpretations, or conclusions made by Contractor based on information made available by Government, in accordance with the clause at FAR 52.236-3, Site Investigations and Conditions Affecting the Work.
- C.    Pump control and sequence logic may change throughout Contractor system design period.

### 1.03 LOGIC DIAGRAMS

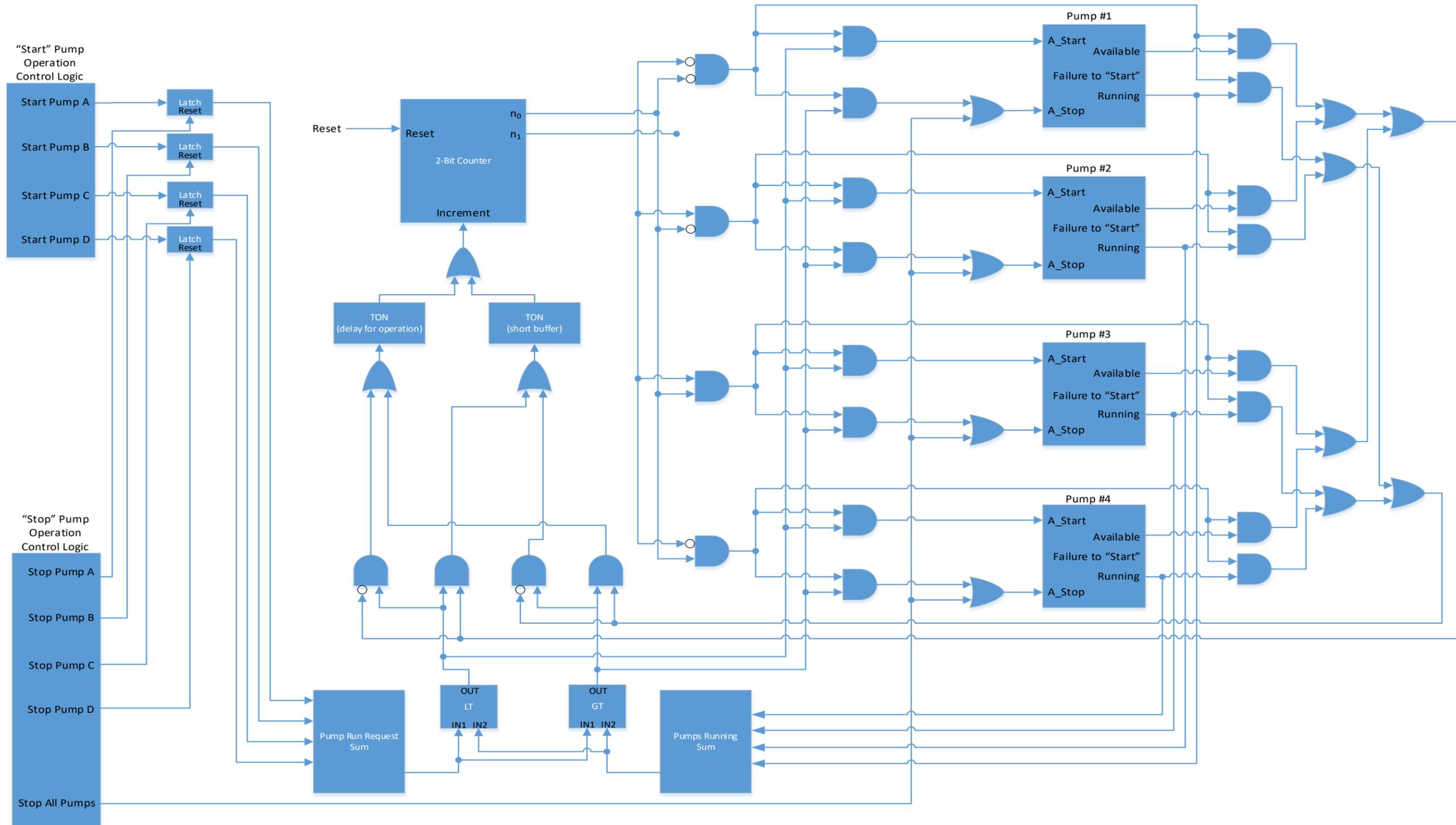
#### A. "Start" Pump Operation Control Logic:



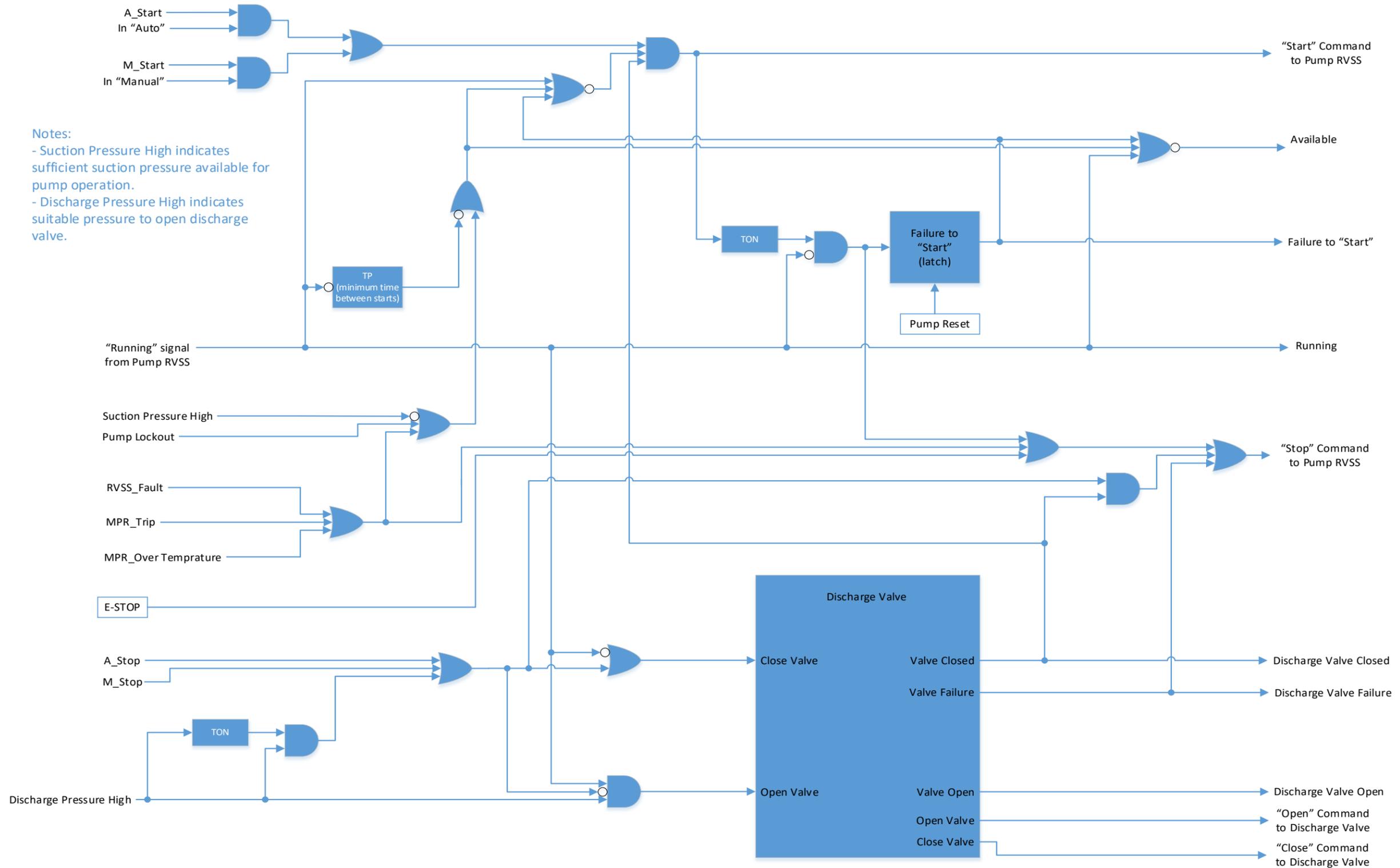
B. "Stop Pump Operation Control Logic:



C. Pump Sequencer:



Pump and Discharge Valve Control Logic:



Notes:  
 - Suction Pressure High indicates sufficient suction pressure available for pump operation.  
 - Discharge Pressure High indicates suitable pressure to open discharge valve.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 51 00 30**  
**UTILITY ACKNOWLEDGEMENTS**

**PART 1 GENERAL**

**1.01 GENERAL**

- A. Listed below are power poles that will be affected during construction of Pumping Plant 4. Government will contact owners of each utility and submit required application or notifications of proposed disturbance.
- B. Copies of permits/agreements will be provided to Contractor once received by FCCO.

**1.02 POWER POLES**

- A. See 01 56 15 – Protection of Existing Utilities for Measurement and Payment.
- B. See Table 51 00 30A – Power Poles for information regarding relocation and/or monitoring during construction.

Table 51 00 30A – Power Poles

Reach	Station	Drawing No.	Action*	Latitude	Longitude
6	6529+15	1695-D-60695	Relocate	36°7'21.02"N	108°42'18.16"W
8	8171+90	1695-D-60708	Monitor	36°7'50.38"N	108°42'19.26"W
8	8236+00	1695-D-60709	Relocate	36°6'48.91"N	108°42'13.12"W
8	8260+00	1695-D-60710	Guy wire in ROW	36°6'25.51"N	108°42'6.42"W
8	8263+50	1695-D-60710	Relocate	36°6'22.83"N	108°42'4.63"W
8	8405+21	1695-D-60713	Monitor	36°4'15.59"N	108°41'2.30"W

\*Consultation with NTUA on power poles is currently ongoing and final relocation determination will be supplied to Contractor prior to construction. NTUA Power Pole contact is in Article C below.

- C. Utility Owner Contact Information:  
 Navajo Tribal Utility Authority – Power Poles  
 Shiprock, NM 87420  
 Phone: 928-729-6213  
 Contact: Dustin Sagg  
 Electrical Engineer  
 Navajo Tribal Utility Authority

**PART 2      PRODUCTS**

Not Used

**PART 3      EXECUTION**

Not Used

**END OF SECTION**

**SECTION 51 00 40**  
**TOHLAKAI FIO NETWORK DIAGRAMS**

**PART 1 GENERAL**

**1.01 NETWORK DIAGRAMS**

# RSN 250001-005-A [SYSTEM CONTROL & MONITORING]

## SCADA NETWORK CABINET, WORKSTATIONS, & ACCESSORIES

NAVAJO GALLUP WATER SUPPLY PROJECT  
 SAN JUAN LATERAL - TOHLAKAI PUMPING PLANT  
 CONTRACT NUMBER: R14PC00018

SPECIFICATION SECTION:  
 SECTION 25 00 01 - SYSTEM CONTROL & MONITORING

**OWNER:**  
 BUREAU OF RECLAMATION

**GENERAL CONTRACTOR:**  
 MOLTZ CONSTRUCTORS, INC.

**ELECTRICAL CONTRACTOR:**  
 MODADE-WOODCOCK, INC.

**SUBMITTED BY:**  
 YUKON & ASSOCIATES, LTD.  
 4211 HAWKINS NE  
 ALBUQUERQUE, NM 87109  
 (505 ) 344-2972



### DRAWING INDEX

SHEET	DWG	DESCRIPTION	SHEET	DWG	DESCRIPTION
		MISCELLANEOUS DRAWINGS			
01	628-SNC-T-01A	SCADA NETWORK CABINET, WORKSTATIONS, & ACCESSORIES - DRAWINGS - TITLE & INDEX SHEET			
02	628-SNC-M-01A	SCADA NETWORK CABINET, WORKSTATIONS, & ACCESSORIES - BILL OF MATERIALS (BOM) I OF II			
03	628-SNC-M-01B	SCADA NETWORK CABINET, WORKSTATIONS, & ACCESSORIES - BILL OF MATERIALS (BOM) II OF II AND NOTES/SYMBOLS			
04	628-SNC-N-01A	SCADA NETWORK CABINET - NETWORK CONNECTION DIAGRAM I OF IV (FIBER OPTIC CONNECTIONS)			
05	628-SNC-N-01B	SCADA NETWORK CABINET - NETWORK CONNECTION DIAGRAM II OF IV (SCADA NETWORK CONNECTIONS)			
06	628-SNC-N-01C	SCADA NETWORK CABINET - NETWORK CONNECTION DIAGRAM III OF IV (CELLULAR NETWORK SV CONNECTIONS)			
07	628-SNC-N-01D	SCADA NETWORK CABINET - NETWORK CONNECTION DIAGRAM IV OF IV (TELEPHONE PBE NETWORK SV CONNS)			
08	628-NTUA-N-01A	NTUA HEADQUARTERS - NETWORK CONNECTION DIAGRAM			
		LAYOUT DRAWINGS			
09	628-SNC-F-01A	SCADA NETWORK CABINET - EXTERIOR FRONT DOOR VIEW, EXTERIOR RIGHT SIDE VIEW, & EXTERIOR BACK DOOR VIEWS			
10	628-SNC-B-01A	SCADA NETWORK CABINET - INTERIOR FRONT BACK VIEW			
		POWER DISTRIBUTION DRAWINGS			
11	628-SNC-P-01A	SCADA NETWORK CABINET - 120VAC POWER DISTRIBUTION			
12	628-SNC-P-02A	SCADA NETWORK CABINET - 24VDC POWER DISTRIBUTION			

**RECLAMATION**  
*Managing Water in the West*

**YUKON & ASSOCIATES, LTD.**  
 CONTRACT NO.: R14PC00018 | SPEC. NO.: 25-0001  
 SCADA NETWORK CABINET  
 WORKSTATIONS, & ACCESSORIES  
 DRAWINGS - TITLE & INDEX SHEET

YUKON CUSTOMER: MWT | YUKON JOB: 035  
 YUKON REV DATE: 09/27/18 | YUKON REV: ASB  
 YUKON DRAWING NUMBER: R14PC00018 | YUKON SHEET #: 01

**ALWAYS THINK SAFETY**

U.S. DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 NAVAJO GALLUP WATER SUPPLY PROJECT  
 NEW MEXICO  
 SAN JUAN LATERAL  
 TOHLAKAI PUMPING PLANT

APR. 08/08/18

SHEET 01 OF 01

DATE AND TIME PLOTTED: 04/11/2018 10:00:00 AM  
 PLOTTED BY: [Name]  
 C:\[Path]\[File Name].dwg

BILL OF MATERIAL (BOM)

BOM	MFG	PART #	DESCRIPTION	TOTAL QTY	PLANT WS	SCADA NETWORK CABINET	NTUA HQ	NOTES
1.1A	HOFFMAN	NC2179	19" RACK NETWORK CABINET WITH 43 RACK UNITS (RU) OF SPACE, FULLY PERFORATED FRONT DOOR, AND LOUVERED REAR DOOR - COLOR: BLACK (84 00" Dx 27.50" Wx 37.50" D)	1	0	1	0	
1.1B	HOFFMAN	AS1032B	10-32 BLACK SCREW PACKAGE FOR RACK MOUNTING HARDWARE (20-PACK)	2	0	2	0	
1.2A	HOFFMAN	DPIN191020	RACK MOUNTED OUTLET STRIP WITH TWO OUTLETS FRONT AND EIGHT OUTLET BREAK - COLOR: BLACK - MODEL #: GEFD1020HV	2	0	2	0	
1.3A	HOFFMAN	P19VSH16B	RACK MOUNTED VENTILATED SHELF	1	0	1	0	
1.4A	MOXA	EK-4U	4U RACK MOUNTED DIN RAIL PANEL WITH 35MM DIN RAIL - COLOR: BLACK	1	0	1	0	
1.5A	PHOENIX CONTACT	5600525 (EM-DUO-120/20)	DUPLEX OUTLET, 20A, DIN-RAIL MOUNTED	1	0	1	0	
1.6A	WEID-MILLER	0583560000	TERMINAL STRIP END ANCHOR - EWS	5	0	5	0	
1.7A	WEID-MILLER	1631930000	TERMINAL STRIP SMALL MARKER - SCHR 5S	5	0	5	0	
1.8A	ROWMARK	322-402	1/16" THICK NAMEPLATE ENGRAVING MATERIAL - BLACK WITH WHITE CORE (BLACK WITH WHITE LETTERS)	AS REQD	0	AS REQD	0	
1.9A	REMCO BOLT	MS05005-C0307198	6-32 X 3/8" MACHINE SCREW, STAINLESS STEEL, PAN HEAD, SLOTTED FOR MOUNTING NAMEPLATES	AS REQD	0	AS REQD	0	
1.10A	SQUARE D	PK9GTA	GROUND BUS FOR CABINET - 2-POSITION	1	0	1	0	
2.1A	ALTRONIX	R1234DC16CB	RACK MOUNTED 24VDC POWER SUPPLY WITH (16) PTC PROTECTED CLASS 2 OUTPUTS - MAX. 18AMP OUTPUT	1	0	1	0	
3.1A	KENDALL HOWARD	5500-3-000-36	OPERATOR CONSOLE - 72" W X 30" D - HEIGHT ADJUSTABLE FROM 28" TO 35" - CONSOLE SURFACE COLOR: FOLKSTONE GRAY	2	1	0	1	
3.2A	KENDALL HOWARD	5500-3-100-68	CPT TOWER HOLDER FOR OPERATOR CONSOLE	2	1	0	1	
3.3A	KENDALL HOWARD	5500-3-100-72	CABLE MANAGEMENT ENCLOSURE FOR OPERATOR CONSOLE	2	1	0	1	
4.1A	MOXA	IKS-6726A-2GTSSFP-4V-HV-T	RACK MOUNTED MANAGED ETHERNET NETWORK SWITCH WITH 8-10/100BASE-TX PORTS, 2-10/100/1000BASE-TX OR 100/1000BASE-SFP COMBO PORTS, 2-SLOTS FOR FAST ETHERNET MODULES, & REDUNDANT 120VAC POWER SUPPLY INPUTS - S/N: TAEFD102977	2	0	1	1	

BILL OF MATERIAL (BOM) - CONTINUED

BOM	MFG	PART #	DESCRIPTION	TOTAL QTY	PLANT WS	SCADA NETWORK CABINET	NTUA HQ	NOTES
4.2A	MOXA	IM-6700A-2SSCATX	FAST ETHERNET MODULE WITH FOUR 10/100BASE-TX PORTS AND TWO SINGLE-MODE 100BASE-FX PORTS WITH SC CONNECTORS (40KM RANGE)	1	0	0	1	
5.1A	MOXA	EDR-810-VPN-2GSFP	DIN-RAIL MOUNTED NETWORK ROUTER WITH 8-10/100BASE-TX PORTS, 2-1000BASE-SFP SLOTS, FIREWALL/NAT/PN, & REDUNDANT 24VDC POWER SUPPLY INPUTS - S/N: TAECD1007554	1	0	1	0	
5.2A	MOXA	EDS-210A-IGTX-1GSFP-4SFP	DIN-RAIL MOUNTED UNMANAGED ETHERNET NETWORK SWITCH WITH 8-10/100BASE-TX PORTS, 4-100BASE-SFP SLOTS, 1-1000BASE-SFP SLOT, & REDUNDANT 24VDC POWER SUPPLY INPUTS (THIS SWITCH IS USED FOR THE P.O. CONNECTIONS TO ROUTER) - S/N: TAEHD1026902	1	0	1	0	
5.3A	MOXA	SFP-1FES1-CT	SINGLE-MODE 100BASE-FX PORT SFP MODULE WITH LC CONNECTOR (40KM RANGE)	2	0	2	0	
6.1A	MOXA	OBU-102-SS-ST	DIN-RAIL MOUNTED TWO-CHANNEL FIBER OPTIC BYPASS UNIT WITH FOUR SINGLE-MODE FIBER OPTIC PORTS WITH ST CONNECTORS & REDUNDANT 24VDC POWER SUPPLY INPUTS - S/N: TAEKBR1046603	2	0	1	1	
7.1A	TRIPP-LITE	N252-048	48-PORT CAT 6 PATCH PANEL - 2U RACK MOUNT	1	0	1	0	
7.2A	ALLEN-TEL	AT1601-BU	CAT 6 PATCH CABLE, 1-FT, BLUE	1	0	1	0	
7.2B	ALLEN-TEL	AT1603-BU	CAT 6 PATCH CABLE, 3-FT, BLUE	5	0	5	0	
7.2C	ALLEN-TEL	AT1610-BU	CAT 6 PATCH CABLE, 10-FT, BLUE	5	0	5	0	
7.2D	ALLEN-TEL	AT1623-BU	CAT 6 PATCH CABLE, 25-FT, BLUE	2	0	2	0	
7.3A	PHOENIX CONTACT	FL-MC-EF-1300-SM-SC (2902856)	24VDC FIBER OPTIC TO 10/100 BASE-T MEDIA CONVERTER - 9/125 UM SINGLE MODE WITH DUPLEX SC FIBER OPTIC CONNECTORS (1500 NM)	1	0	1	0	
8.1A	DELL	R470	FLANT SERVER WITH 16GB RAM, 1TB REDUNDANT RAID HARD DRIVES, MSOFFICE PRO, ADOBE ACROBAT PRO, & SYMANTEC ANTIVIRUS SOFTWARE	1	0	1	0	
8.2A	SYNERGY GLOBAL TECH.	LCD1U20-01-N-CO-USB	RACK MOUNTED 1U - 20" LCD MONITOR WITH INTEGRATED KEYBOARD & TOUCHPAD FOR FLANT SERVER	1	0	1	0	

RECLAMATION

YUKON & ASSOCIATES, LTD  
 ORDER NO: 20230013 SPEC. NO: 250001  
 YUKON JOB: 023  
 YUKON REV. DATE: 03/02/24  
 YUKON REV. BY: ASB  
 YUKON DRAWING NUMBER: YUKON SHEET #:  
 02

ALWAYS THINK SAFETY  
 THE DEPARTMENT OF THE ENERGY  
 WINDO CHUKUR WATER SUPPLY PROJECT  
 NEW WEZED  
 SHAN JUAN LATERAL  
 TOHLAKAI PUMPING PLANT

DATE AND TIME PLANTED  
 PLANTED BY  
 DRAWN BY  
 CHECKED BY  
 DATE  
 SHEET OF

DATE AND TIME PLANTED  
 PLANTED BY  
 DRAWN BY  
 CHECKED BY  
 DATE  
 SHEET OF

BILL OF MATERIAL (BOM) - CONTINUED

BOM	MFG	PART #	DESCRIPTION	TOTAL QTY	PLANT WS	SCADA NETWORK CABINET	NTUA HQ	NOTES
9.1A	DELL	T1700	OPERATOR WORKSTATION WITH 8GB RAM, 1TB HARD DRIVE, WINDOWS 7 PRO 64-BIT OPERATING SYSTEM, MSOFFICE PRO, ADOBE ADOBE ACROBAT PRO, & MCAFEE ANTIVIRUS SOFTWARE	2	1	0	1	
9.2A	DELL	P2214H	22" LCD MONITOR WITH DP PORT, VGA PORT, & DVI-D PORT	4	2	0	2	
10.1A	LIEBERT (EMERSON)	GXT4-1500RT120	1500VA 120VAC TOWER/RACK UPS SYSTEM FOR COMPUTER WORKSTATIONS - 31 MINUTE RUNTIME AT CALCULATED LOAD	2	1	0	1	
10.2A	LIEBERT (EMERSON)	IS-RELAY	UPS RELAY INTERFACE CARD	2	1	0	1	
11.1A	XEROX	PHASER 7100	11" X 17" COLOR LASER PRINTER WITH 1200x1200 RESOLUTION, 10/100BASE-TX ETHERNET PORT & USB PORT	1	1	0	0	
12.1A	TYCO (RAYCHEM)	TMS-SCE-K-1/4-2L0-9	HEAT SHRINK WIRE LABELS FOR #10-22 AWG WIRE (EA)	AS REQ'D	0	AS REQ'D	0	
12.2A	PANDUIT	PV14-P47-C	PIN TERMINAL CONNECTOR - 16-14AWG - BLUE VINYL INSULATED (100 PER PKG)	AS REQ'D	0	AS REQ'D	0	
12.3A	GENERAL CABLE	1015-14AWG-BLU	PANEL WIRE, MTW 14 AWG STRANDED, TINNED COPPER BLACK (FEET) (FOR 24VDC WIRING INSIDE CABINET)	AS REQ'D	0	AS REQ'D	0	
13.1A	GE MDS	SD09-MDCESNNSNN	MAS SD-9 REMOTE RADIO TRANCEIVER WITH ETHERNET PORT, TWO RS-232 PORTS, & 928-960 MHZ FREQUENCY RANGE	1	0	1	0	SUPPLIED BY THE GOVERNMENT.
14.1A	CITECT SCHNEIDER	VJC169922	VIDEO CITECT BOX - DEVELOPMENT WORKSHOP - INCLUDES VIDEO CITECT SOFTWARE DVD, I/O DRIVERS PACK CD, INSTALLATION GUIDE, AND USB HARDWARE KEY	1	0	1	0	
14.2A	CITECT SCHNEIDER	VJCN8101114	VIDEO CITECT SERVER SOFTWARE - 5000 POINT LICENSE (INSTALLED ON THE SERVER COMPUTER)	1	0	1	0	
14.3A	CITECT SCHNEIDER	VJCN8102014	VIDEO CITECT CONTROL CLIENT SOFTWARE - 5000 POINT LICENSE (INSTALLED ON PLANT OPERATOR WORKSTATION)	1	1	0	0	
14.3B	CITECT SCHNEIDER	VJCN8103099	VIDEO CITECT VIEW ONLY CLIENT SOFTWARE - 5000 POINT LICENSE (INSTALLED ON NTUA OPERATOR WORKSTATION)	1	0	0	1	
14.4A	CITECT SCHNEIDER	VJHNS211012	VIDEO HISTORIAN SOFTWARE - 500 POINT LICENSE (INSTALLED ON THE SERVER COMPUTER)	1	0	1	0	
14.4B	CITECT SCHNEIDER	VJHNS212400	VIDEO HISTORIAN DEVICE CLIENT ACCESS LICENSE [CAL] (INSTALLED ON BOTH WORKSTATIONS)	2	1	0	1	
14.5A	SPECTER INSTR.	WIN-911/PRO-BT-PV	WIN-911 PRO ALARM AUTO DIALER SOFTWARE INCLUDING PREMIUM VOICE AND A WIN-911 EXTERNAL USB MODEM (INSTALLED ON THE SERVER COMPUTER)	1	0	1	0	

### SCHEMATIC SYMBOLS


### INTERNAL PANEL WIRE COLOR & TYPE

UNLESS OTHERWISE NOTED ON DRAWINGS

120VAC POWER	BLACK, MTW
AC NEUTRAL	WHITE, MTW
GROUND	GREEN, MTW
FOREIGN VOLTAGE	YELLOW, MTW
+24VDC CONTROL/POWER	BLUE, MTW
-24VDC CONTROL/POWER	BLUE, MTW
DC ANALOG ++	RED LEAD OF 18 AWG TSP
DC ANALOG --	BLACK LEAD OF 18 AWG TSP

**NOTES:**  
 FOR PANEL CIRCUITS WITH 5A OR LESS OVERCURRENT PROTECTION, WIRE GAUGE SHALL BE 18 AWG AND FOLLOW THE SAME COLOR CODE AS SHOWN ABOVE.  
 FOR PANEL CIRCUITS WITH 15A OVERCURRENT PROTECTION, WIRE GAUGE SHALL BE 16 AWG AND FOLLOW THE SAME COLOR CODE AS SHOWN ABOVE.  
 FOR PANEL CIRCUITS WITH 15A OVERCURRENT PROTECTION, WIRE GAUGE SHALL BE 14 AWG AND FOLLOW THE SAME COLOR CODE AS SHOWN ABOVE.  
 FOR PANEL CIRCUITS WITH 20A OVERCURRENT PROTECTION, WIRE GAUGE SHALL BE 12 AWG AND FOLLOW THE SAME COLOR CODE AS SHOWN ABOVE.  
 FOR PANEL CIRCUITS WITH 30A OVERCURRENT PROTECTION, WIRE GAUGE SHALL BE 10 AWG AND FOLLOW THE SAME COLOR CODE AS SHOWN ABOVE.

### WIRING SYMBOLS

----- ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD WIRING INSTALLED BY OTHERS.  
 \_\_\_\_\_ ALL WIRES (LINES) THAT ARE SOLID REPRESENT INTERNAL PANEL WIRING.

### RECLAMATION

Managing Water in the West

YUKON & ASSOCIATES, LTD.	PROJECT NO: 140R4020C0013	SPEC. NO: 28-0031	DRAWING NO: 140R4020C0013-01
DATE: 08/20/13	TITLE: SCADA NETWORK CABINET - WORK STATIONS, & ACC - BILL OF MATERIALS (BOM) - II OF II & NOTES/SYMBOLS	YUKON JOB: 023	YUKON REV: 003
YUKON CUSTOMER: IAWA	YUKON JOB: 023	YUKON REV: 003	YUKON SHEET #: 01
YUKON REV DATE: 08/20/13	YUKON REV: 003	YUKON REV: 003	YUKON SHEET #: 01

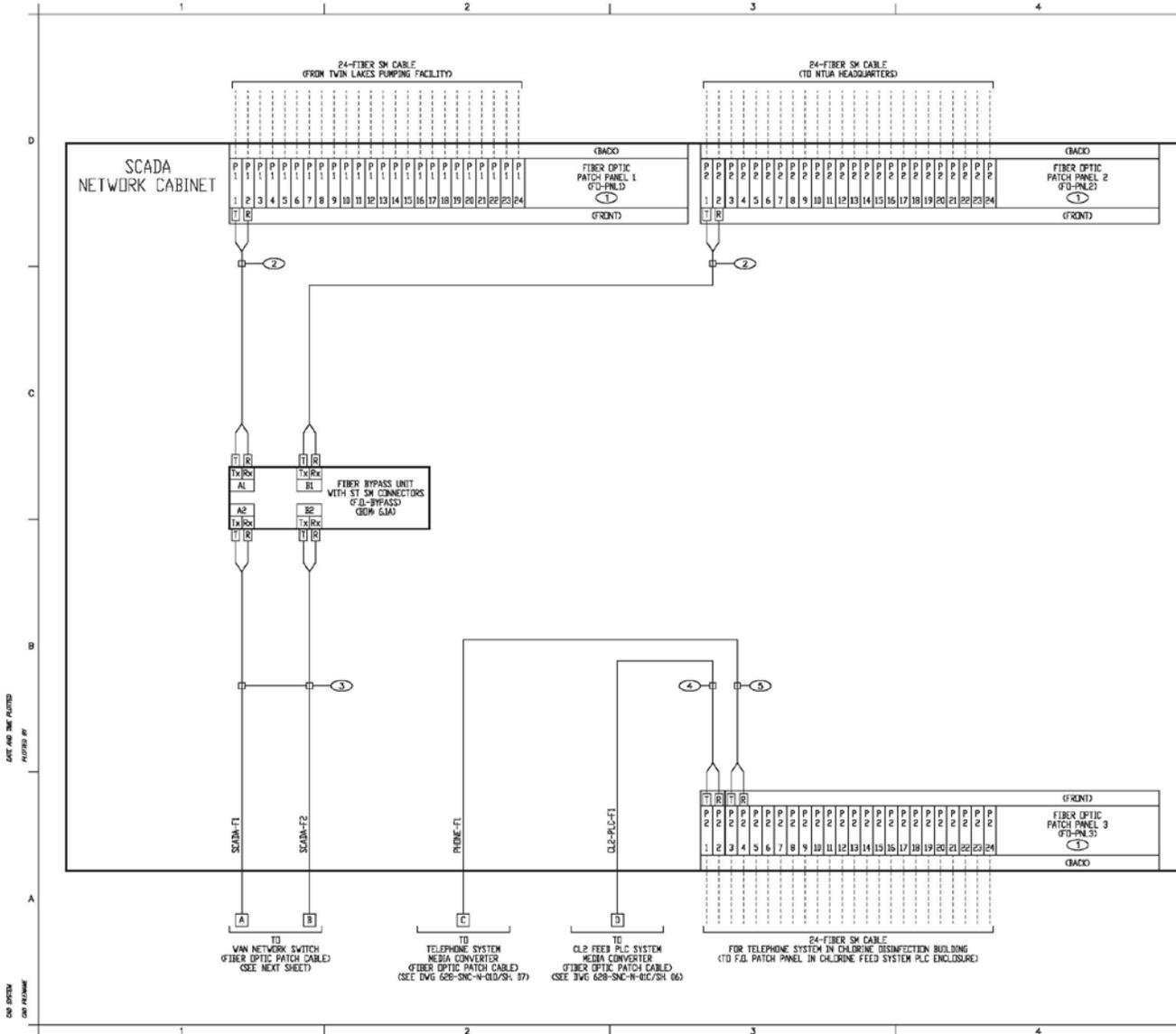
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ALWAYS THINK SAFETY

THE GOVERNMENT OF THE STATE OF CALIFORNIA  
 WATER RESOURCES DIVISION  
 ANAHEIM CALIFORNIA WATER SUPPLY PROJECT  
 NEW METZ  
 SAN JUAN LATERAL  
 TOHLKAKI PUMPING PLANT

---

DATE AND TIME PLotted  
 PLOTTED BY  
 SHEET 01 OF 01



**GENERAL NOTES:**  
 1. ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD FIBER OPTIC COMMUNICATION CABLES SUPPLIED & INSTALLED BY OTHERS.

- KEYED NOTES:**
1. FIBER OPTIC PATCH PANEL SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 33-82-23-2.03A-1.
  2. FIBER OPTIC ST TO ST SM PATCH CABLE SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 33-82-23-2.04.
  3. FIBER OPTIC ST TO LC SM PATCH CABLE SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 33-82-23-2.04.
  4. FIBER OPTIC SM PATCH CABLE SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 33-82-23-2.04. SC CONNECTORS AS REQUIRED TO CONNECT TO CHLORINE FEED PLC SYSTEM MEDIA CONVERTER.
  5. FIBER OPTIC SM PATCH CABLE SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 33-82-23-2.04. CONNECTORS AS REQUIRED TO CONNECT TO TELEPHONE SYSTEM POE MEDIA CONVERTER.

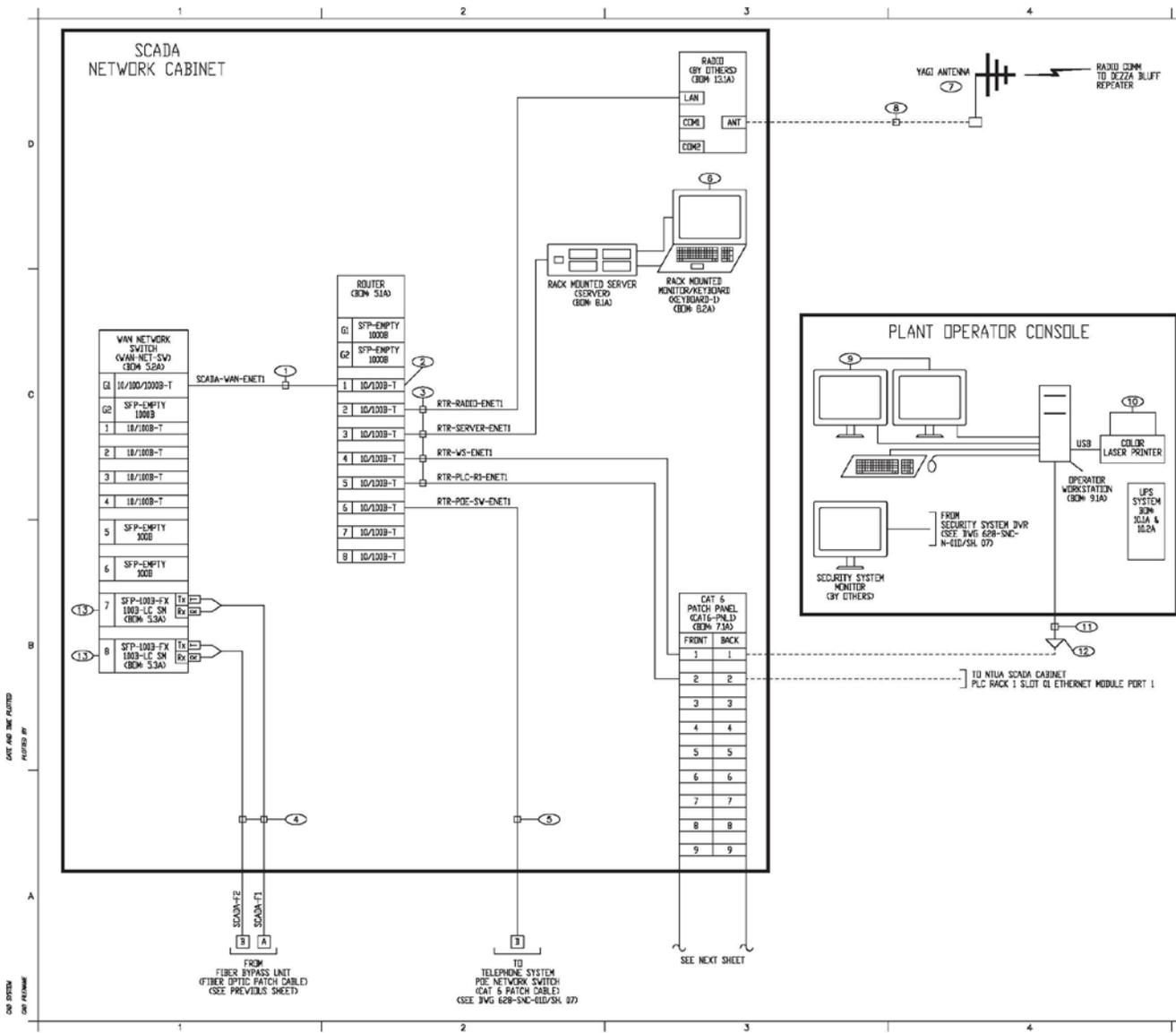
**RECLAMATION**  
*Managing Water in the West*

**YUKON & ASSOCIATES, LTD.**  
 10000 100th Ave. Suite 1000, Edmonton, Alberta T5A 0A6  
 TEL: 780-443-8888 FAX: 780-443-8889  
 WWW.YUKON-ASSOCIATES.COM

**PROJECT INFORMATION:**  
 PROJECT NO.: 140R4020C0013  
 SHEET NO.: 01 OF 01  
 PROJECT TITLE: SCADA NETWORK CABINET NETWORK CONNECTION DIAGRAM 1 OF 1V  
 (FIBER OPTIC CONNECTIONS)  
 YUKON JOB #: 622  
 YUKON REV. DATE: 03/20/18  
 YUKON REV. BY: JAD  
 YUKON DRAWING NUMBER: 140R4020C0013-01

**CLIENT:**  
 ALWAYS THINK SAFETY  
 U.S. DEPARTMENT OF THE INTERIOR  
 BUREAU OF LAND MANAGEMENT  
 ANAHELO CHLORINE WATER SUPPLY PROJECT  
 NEW MEXICO  
 SAN JUAN LATERAL  
 TOHLAKAI PUMPING PLANT

**DATE:** 2017-03-27  
**BY:** JEROME CALABRO  
**CHECKED BY:** JEROME CALABRO  
**DATE:** 2017-03-27  
**BY:** JEROME CALABRO

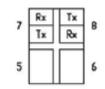


**GENERAL NOTES:**

- ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD COMMUNICATION CABLES SUPPLIED & INSTALLED BY OTHERS.

**KEYED NOTES:**

- ONE FOOT BLUE CAT 6 PATCH CABLE (CWM-72A).
- PROGRAM THIS PORT 1 OF THE ROUTER TO BE THE WAN PORT.
- TEN FOOT BLUE CAT 6 PATCH CABLE (CWM-72C).
- FIBER OPTIC ST TO LC SM PATCH CABLE SUPPLIED BY OTHERS PER SPEC. SECTION 33-82-23-204.
- TELEPHONE SYSTEM CAT 6 PATCH CABLE SUPPLIED & INSTALLED BY THE TELEPHONE SYSTEM SUPPLIER.
- RACK MOUNTED 20" LCD MONITOR & KEYBOARD/TOUCHPAD (CWM-62A) FOR THE SERVER COMPUTER.
- RADIO SYSTEM ANTENNA & ALL ACCESSORIES SUCH AS GROUND KITS, WEATHERPROOF KITS, AND CONNECTORS ARE SUPPLIED & INSTALLED BY OTHERS.
- RADIO SYSTEM ANTENNA CABLE & ALL ACCESSORIES SUCH SURGE PROTECTORS AND CONNECTORS ARE SUPPLIED & INSTALLED BY OTHERS.
- DUAL 22" LCD MONITORS (CWM-92A).
- 11"x17" COLOR LASER PRINTER (CWM-111A).
- TWENTY-FIVE FOOT BLUE CAT 6 PATCH CABLE (CWM-72D).
- THIS DUAL PORT RJ-45 DATA JACK IS SUPPLIED & INSTALLED BY OTHERS ON THE CONTROL ROOM WEST WALL. ONLY DUAL DATA JACKS. THE WORKSTATION COMPUTER IS CONNECTED TO PORT 1 OF THIS DUAL PORT DATA JACK.
- THE FOLLOWING IS A DIAGRAM OF THE TRANSMIT/RECEIVE PORTS ON THIS MIXA NETWORK SWITCH



**RECLAMATION**  
*(Managing Water in the West)*

**YUKON & ASSOCIATES, LTD.**  
 CONSULTING ENGINEERS  
 1000 BROADWAY, SUITE 1000  
 VANCOUVER, BC V6Z 2R6  
 TEL: 604-681-1111  
 FAX: 604-681-1112  
 PROJECT NO: 140R4020C0013  
 SHEET NO: 01 OF 02

**ALWAYS THINK SAFETY**  
 THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA  
 MINISTRY OF WATER SUPPLY, PROJECT  
 NEW WEIR  
 SAN JUAN LATERAL  
 TOHLAKAI PUMPING PLANT

DATE AND TIME PLOTTED: 11/11/2011 10:00 AM  
 PLOTTED BY: J. SMITH

DESIGN: D. GILGUS  
 SHEET 01 OF 02

GENERAL NOTES:

- ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD CAT 6 COMMUNICATION CABLES SUPPLIED & INSTALLED BY OTHERS.

KEYED NOTES:

- THREE FOOT BLUE CAT 6 PATCH CABLE (BOM: 7.2B).
- TEN FOOT BLUE CAT 6 PATCH CABLE (BOM: 7.2C).
- FIBER OPTIC SM PATCH CABLE SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 33-82-23-2.04. SC CONNECTORS AS REQUIRED TO CONNECT TO CHLORINE FEED PLC SYSTEM MEDIA CONVERTER.

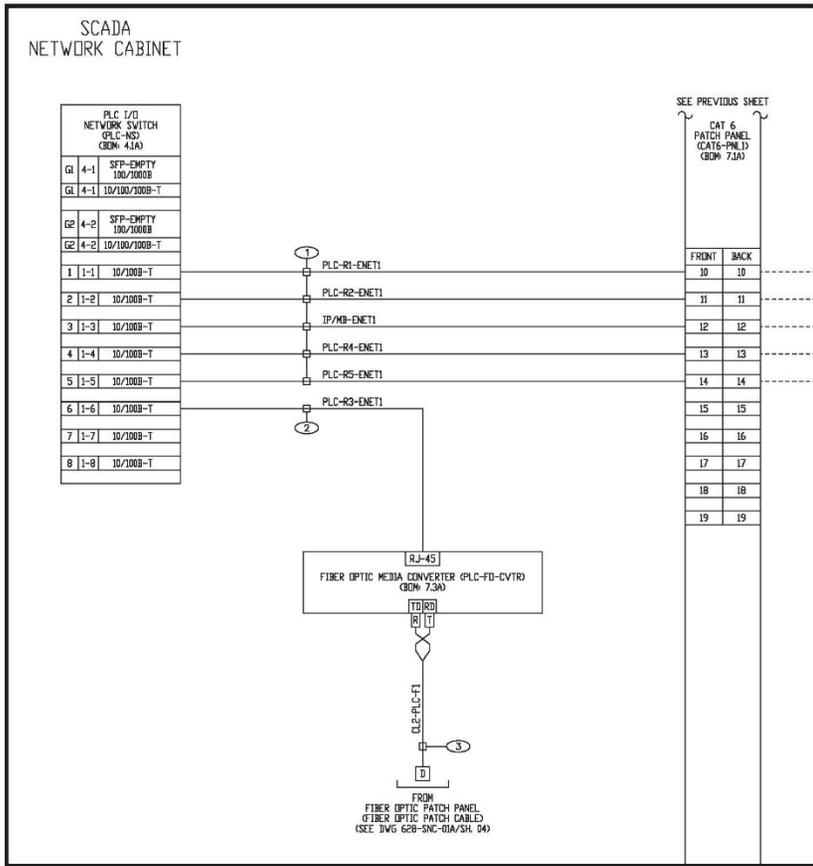
RECLAMATION  
*Managing Water in the West*

YUKON & ASSOCIATES, LTD.	PROJECT NUMBER: 15PEC-1061-250000
YUKON DRAWING TITLE:	SCADA NETWORK CABINET NETWORK CONNECTION DIAGRAM III OF IV (PLC I/O NETWORK SW CONNECTIONS)
YUKON CUSTOMER:	MWH
YUKON REV. DATE:	2017-03-17
YUKON REV. ASB	YUKON REV. ASB
YUKON DRAWING NUMBER:	140R4020C0013
YUKON SHEET #:	03

ALWAYS THINK SAFETY  
U.S. DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
NANAO GALLUP WATER SUPPLY PROJECT  
NEW MEXICO  
SAN JUAN LATERAL  
TOHLAKAI PUMPING PLANT

DEMETER COLLINS

SHEET 03



SEE PREVIOUS SHEET

CAT 6 PATCH PANEL (CAT6-PHELD) (BOM: 7.2A)

FRONT	BACK
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19

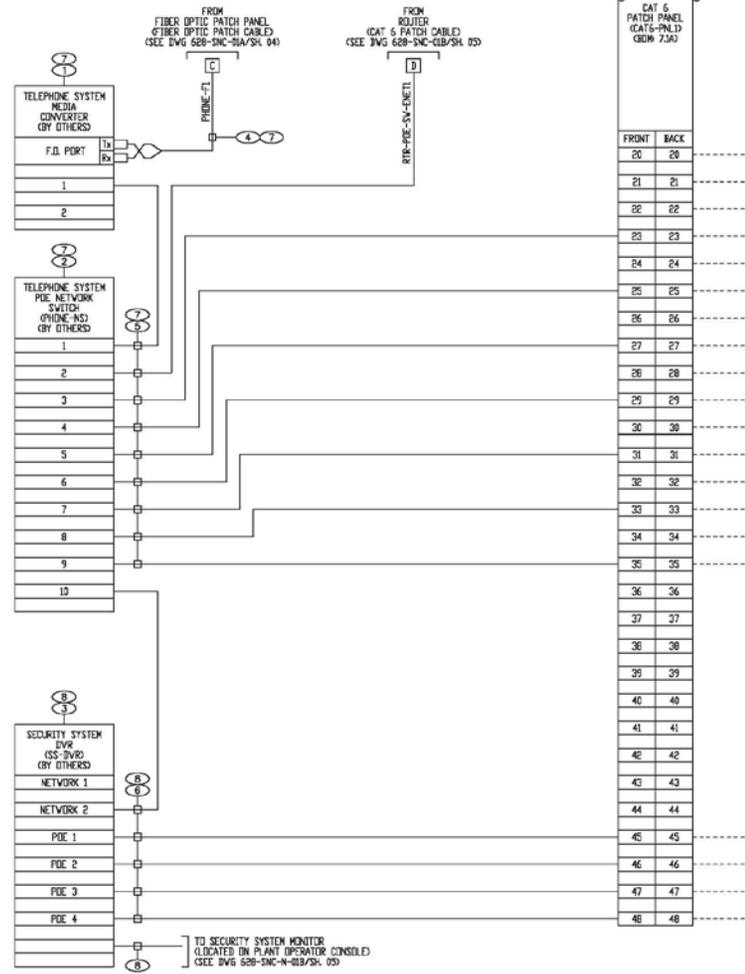
SEE NEXT SHEET

- TO NTUA SCADA CABINET PLC RACK 1 SLOT III ETHERNET MODULE PORT 2
- TO NTUA SCADA CABINET PLC RACK 2 SLOT III ETHERNET MODULE PORT 1
- TO NTUA SCADA CABINET MIBUS TO ETHERNET GATEWAY
- TO AIR CHAMBER 121 PLC CONTROL PANEL (PLC RACK 4 (AIR CHAMBER 121) PLC ETHERNET PORT)
- TO AIR CHAMBER 12B PLC CONTROL PANEL (PLC RACK 5 (AIR CHAMBER 12B) PLC ETHERNET PORT)

DATE AND TIME PLOTTED  
PLOTTED BY

JOB SYSTEM  
JOB FILENAME

SCADA NETWORK CABINET



GENERAL NOTES:

- ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD CAT 6 COMMUNICATION CABLES SUPPLIED & INSTALLED BY OTHERS.

KEYED NOTES:

- TELEPHONE SYSTEM MEDIA CONVERTER SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 27-30-00-2.03.
- TELEPHONE SYSTEM PDE NETWORK SWITCH SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 27-30-00-2.02.
- SECURITY SYSTEM DIGITAL VIDEO RECORDER (DVR) SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 28-10-01-2.01.
- FIBER OPTIC SM PATCH CABLE SUPPLIED BY OTHERS PER SPEC. SECTION 33-80-23-2.04. CONNECTORS AS REQUIRED TO CONNECT TO TELEPHONE SYSTEM PDE MEDIA CONVERTER.
- TELEPHONE SYSTEM CAT 6 PATCH CABLE SUPPLIED & INSTALLED BY THE TELEPHONE SYSTEM SUPPLIER.
- SECURITY SYSTEM CAT 6 PATCH CABLE SUPPLIED & INSTALLED BY THE SECURITY SYSTEM SUPPLIER.
- THE TELEPHONE SYSTEM NETWORK CONNECTIONS SHOWN ON THIS DRAWING ARE YUKON'S INTERPRETATION OF THE CONTRACT DRAWINGS AND SPECIFICATIONS. FINAL DESIGN OF THE TELEPHONE SYSTEM NETWORK CONNECTIONS IS THE RESPONSIBILITY OF THE TELEPHONE SYSTEM SUPPLIER.
- THE SECURITY SYSTEM NETWORK CONNECTIONS SHOWN ON THIS DRAWING ARE YUKON'S INTERPRETATION OF THE CONTRACT DRAWINGS AND SPECIFICATIONS. FINAL DESIGN OF THE SECURITY SYSTEM NETWORK CONNECTIONS IS THE RESPONSIBILITY OF THE SECURITY SYSTEM SUPPLIER.

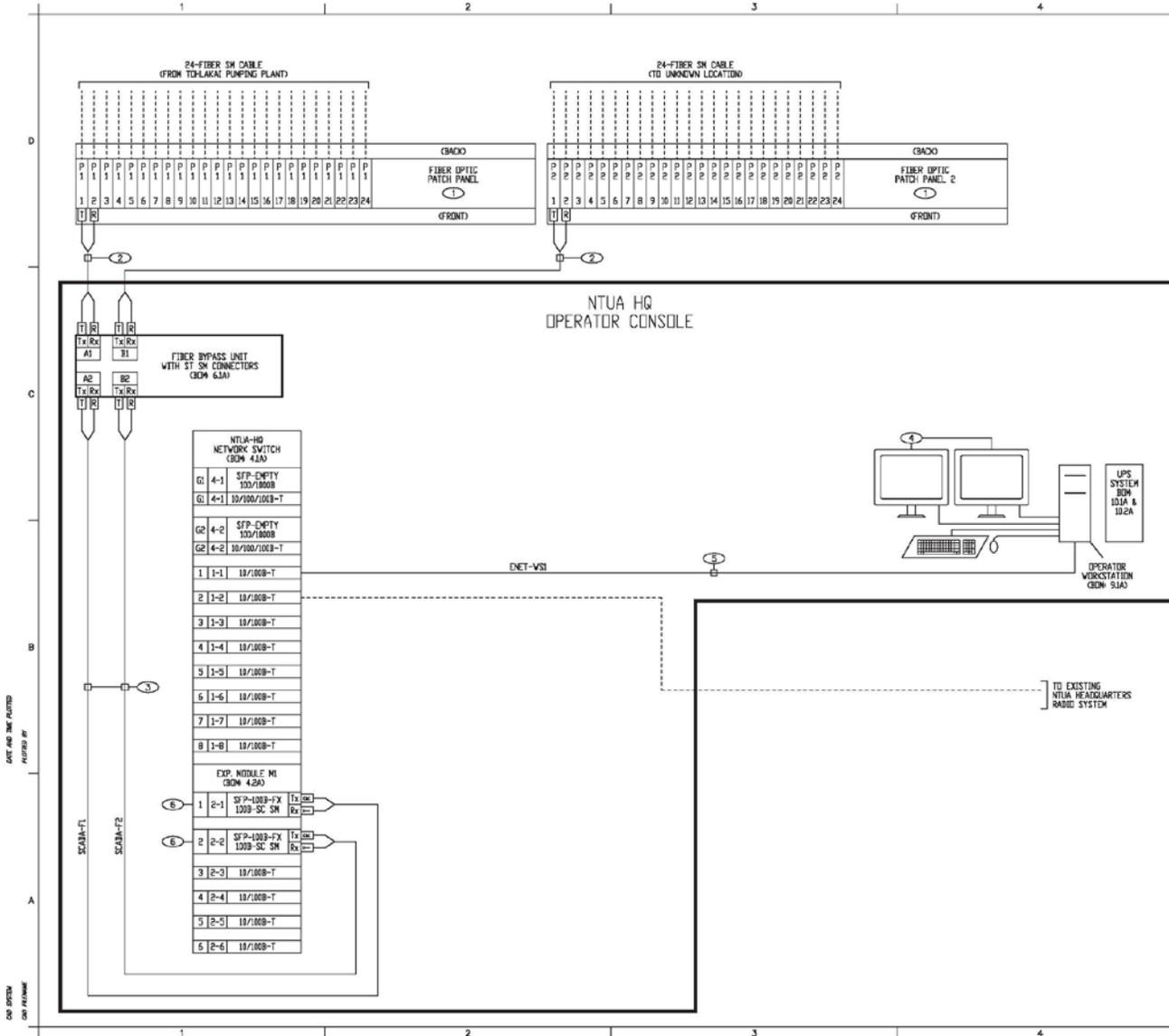
RECLAMATION

YUKON & ASSOCIATES, LTD.  
 PROJECT NO: 140R4020  
 SHEET NO: 01  
 DRAWING TITLE: SCADA NETWORK CABINET NETWORK CONNECTION DIAGRAM IV OF IV (TELEPHONE POE NETWORK SW. CONN.)  
 YUKON CUSTOMER: IMAI  
 YUKON JOB#: 622  
 YUKON REV. DATE: 03/20/18  
 YUKON REV. BY: JG  
 YUKON DRAWING NUMBER: 140R4020-01  
 YUKON SHEET #: 01

ALWAYS THINK SAFETY  
 THE GOVERNMENT OF THE YUKON  
 HANNO COLLEGE WATER SUPPLY PROJECT  
 NEW METHOD  
 SHAN JUAN LATERAL  
 TOHLAKAI PUMPING PLANT

DESIGNED BY: JEROME CALAGUPO  
 DRAWN BY: JEROME CALAGUPO  
 CHECKED BY: JEROME CALAGUPO  
 DATE: 2017-03-17

DATE AND TIME PLANTED  
 PLANTED BY  
 SHEET OF



GENERAL NOTES:

1. ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD COMMUNICATION CABLES SUPPLIED & INSTALLED BY OTHERS.

KEYED NOTES:

- 1 THIS FIBER OPTIC PATCH PANEL IS SUPPLIED & INSTALLED BY OTHERS.
- 2 FIBER OPTIC SM PATCH CABLE SUPPLIED & INSTALLED BY OTHERS. SC CONNECTORS TO CONNECTORS AS REQUIRED TO CONNECT TO THE FIBER OPTIC PATCH PANELS.
- 3 FIBER OPTIC ST TO ST SM PATCH CABLE SUPPLIED & INSTALLED BY OTHERS.
- 4 DUAL 22" LCD MONITORS (02M 92A).
- 5 TWENTY-FIVE FOOT BLUE CAT 6 PATCH CABLE (02M 72D).
- 6 THE FOLLOWING IS A DIAGRAM OF THE TRANSMIT/RECEIVE PORTS ON THIS MOXA NETWORK SWITCH:



RECLAMATION

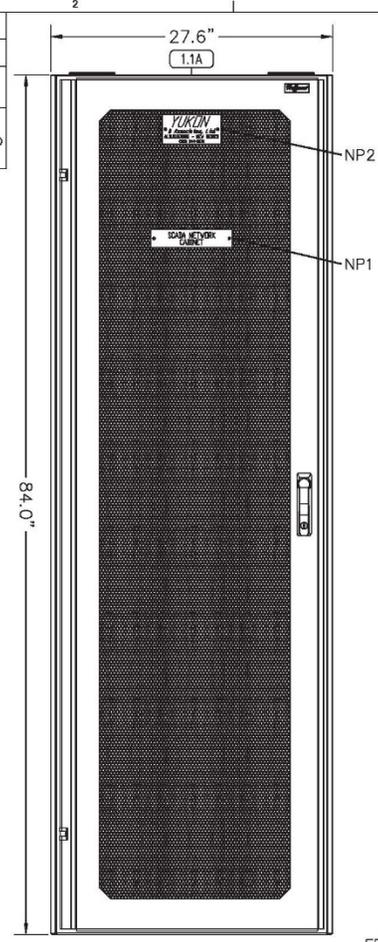
Managing Water in the West

YUKON & ASSOCIATES, LTD.  
 CONTRACT NO. 2007013 | SPEC. NO. 25-0001  
 PROJECT TITLE:  
 NTUA HEADQUARTERS NETWORK CONNECTION DIAGRAM  
 YUKON CUSTOMER: IAWA | YUKON JOB: 02  
 YUKON REV. DATE: 03/2011 | YUKON REV. 03-03  
 YUKON DRAWING NUMBER: 140R4020C0013 | YUKON SHEET #: 03

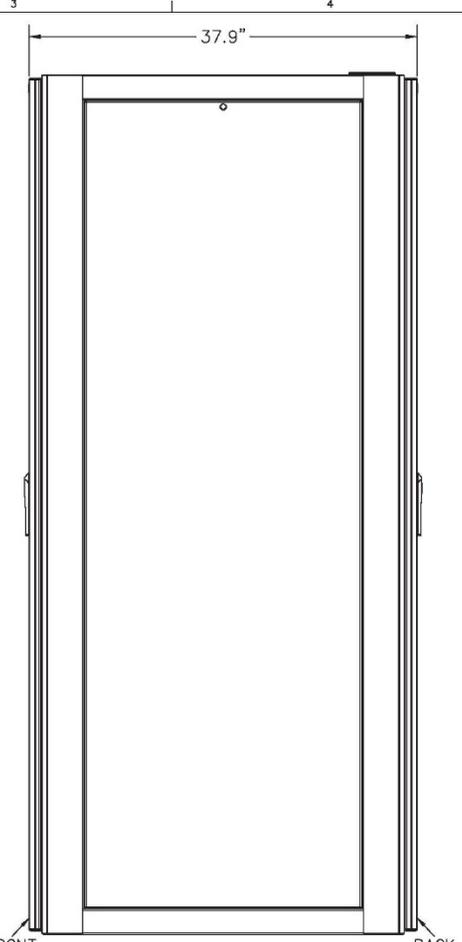
ALWAYS THINK SAFETY  
 U.S. DEPARTMENT OF THE INTERIOR  
 BUREAU OF LAND MANAGEMENT  
 HAWAII OILFIELD WATER SUPPLY PROJECT  
 NEW METHOD  
 SHAN JUAN LATERAL  
 TOHLAKAI PUMPING PLANT

DATE AND TIME PLANNED  
 DESIGNED BY  
 DRAWN BY  
 CHECKED BY  
 APPROVED BY  
 DATE: 2012-03-27  
 SHEET 03 OF

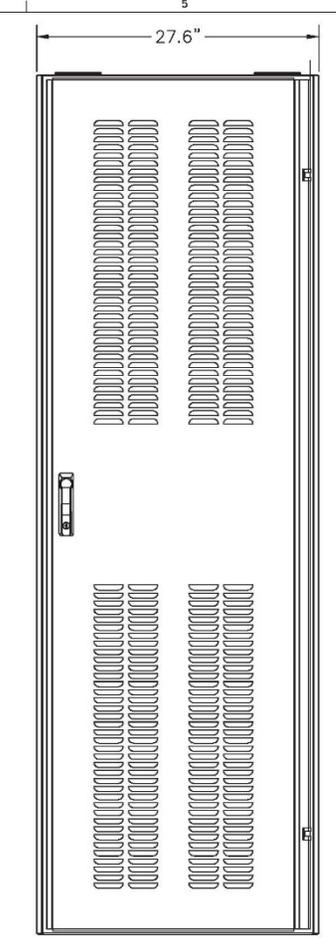
NAMEPLATE LEGEND					
ID	NP MATERIAL	NP SIZE	NP COLOR	TEXT HEIGHT	NAMEPLATE
NP1	BOM:1.8A	1-3/4" T x 8" W	BLACK WITH WHITE LETTERS	1/2"	SCADA NETWORK CABINET
NP2	BOM:1.8A	2-7/8" T x 5-3/4" W	BLACK WITH WHITE LETTERS	VARIOUS	YUKON & Associates, Ltd. ALBUQUERQUE - NEW MEXICO (505) 344-2972



SCADA NETWORK CABINET  
EXTERIOR FRONT DOOR VIEW  
(84.0"Tx27.6"Wx37.9"D)



SCADA NETWORK CABINET  
EXTERIOR RIGHT SIDE VIEW  
(84.0"Tx27.6"Wx37.9"D)



SCADA NETWORK CABINET  
EXTERIOR BACK DOOR VIEW  
(84.0"Tx27.6"Wx37.9"D)



DATE AND TIME PLOTTED  
PLOTTER BY  
B  
C  
D  
A  
ONE SYSTEM  
ONE PLANING

DEVICE TORQUE SETTINGS	
DEVICE	TORQUE (LBS. IN)
TERMINALS (RECEPTACLE TERMINALS)	30
GROUND BARS (CLEAN)	250
GROUND BARS (GRAVED)	250

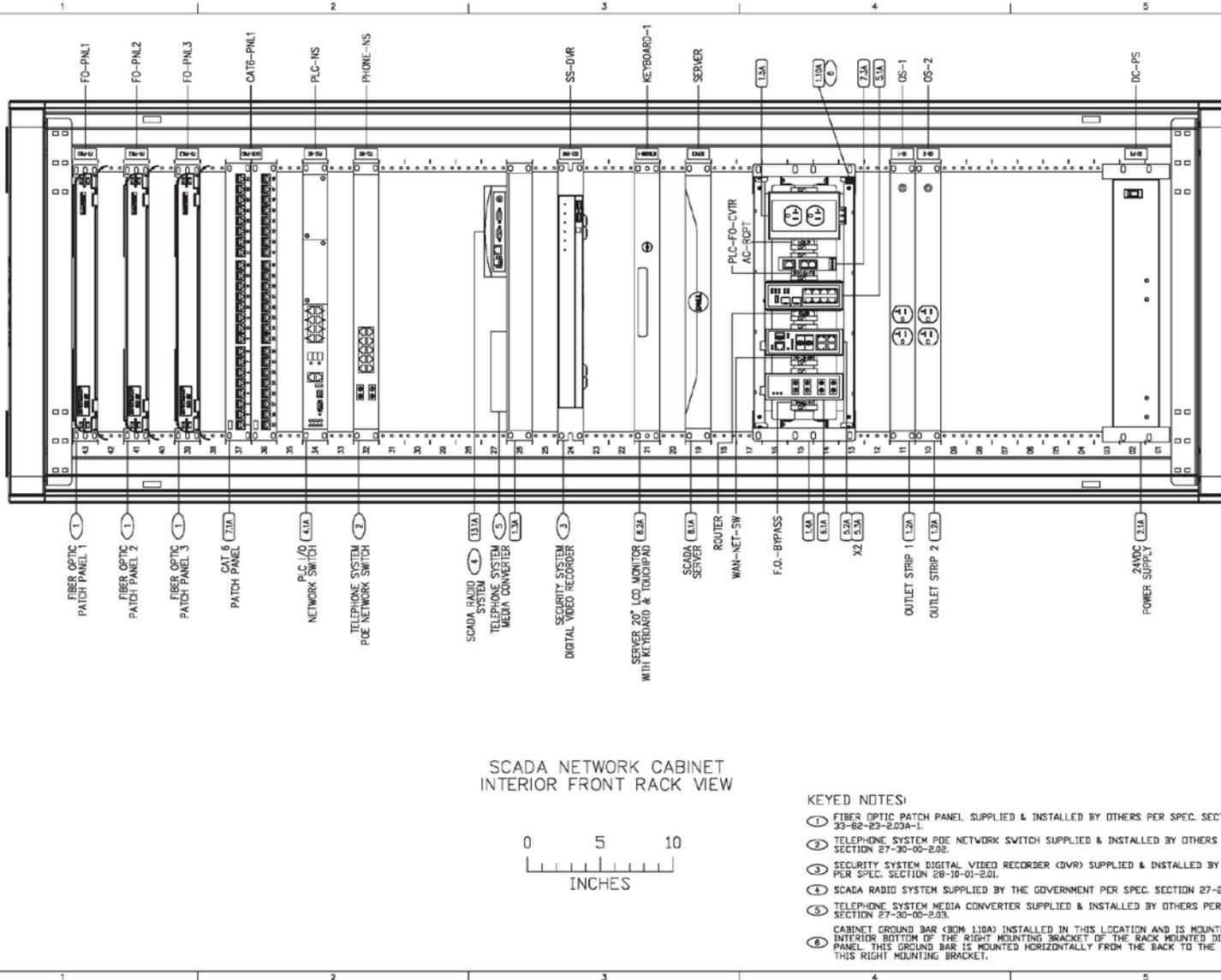
INTERNAL CONDUCTOR OVERCURRENT PROTECTION IS DEPENDENT UPON PROTECTIVE DEVICES PROVIDED BY OTHERS. THE PROTECTIVE DEVICES USED SHALL NOT EXCEED THE FOLLOWING MAXIMUM VALUES:

TYPE OF WIRE IN PANEL	AWG	PROTECTIVE DEVICE MAX. AMPS
CONTROL WIRE	10	50A
CONTROL WIRE	12	25A
CONTROL WIRE	14	15A
CONTROL WIRE/1SP	16	10A
CONTROL WIRE/1SP	18	7A

<b>RECLAMATION</b> <i>Managing Water in the West</i>	
YUKON & ASSOCIATES, LTD. 1500 N. 10TH ST. SUITE 100 ANCHORAGE, ALASKA 99503 TEL: 907-562-1111 FAX: 907-562-1112 WWW.YUKON-AS.COM	SPEC. NO.: 250000 YUKON DRAWING TITLE: SCADA NETWORK CABINET EXTERIOR FRONT DOOR, EXTERIOR RIGHT SIDE & EXTERIOR BACK DOOR VIEWS YUKON CUSTOMER: MVM YUKON JOB#: 02E YUKON REV. DATE: 08/22/05 YUKON REV.: ASB YUKON DRAWING NUMBER: YUKON SHEET #: 03
ALWAYS THINK SAFETY U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT GRAND CANYON WATER SUPPLY PROJECT NEW MEXICO SAN JUAN LATERAL TOHLAKAI PUMPING PLANT	
SHEET NO.: 03 OF 12 DATE: 08/22/05 DRAWN BY: MVM CHECKED BY: MVM APPROVED BY: MVM	SHEET OF

DATE AND TIME PLOTTED  
PLOTTED BY

ONE SYSTEM  
ONE PLANVIEW



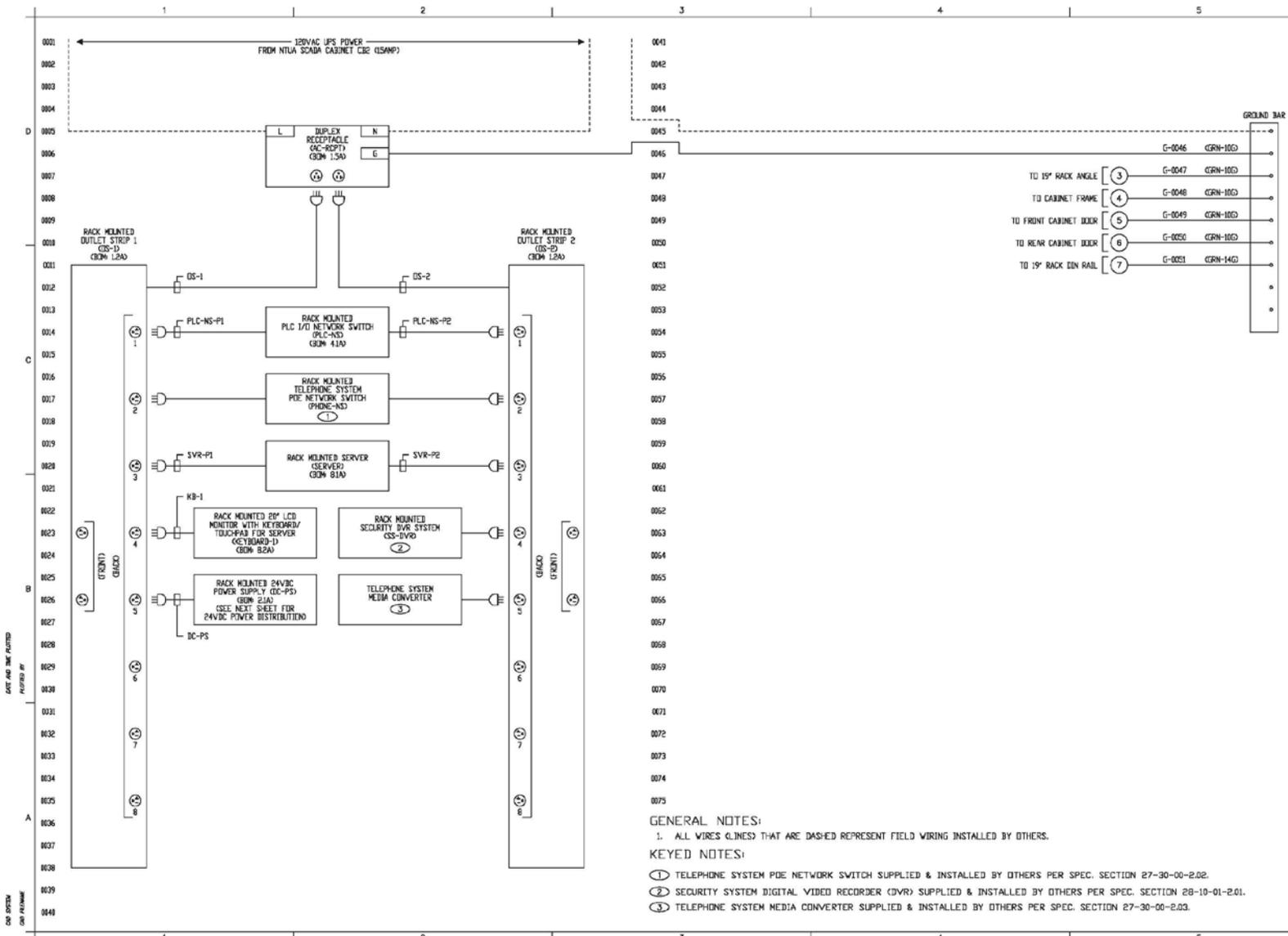
SCADA NETWORK CABINET  
INTERIOR FRONT RACK VIEW



KEYED NOTES:

- ① FIBER OPTIC PATCH PANEL SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 33-82-23-2.03A-1.
- ② TELEPHONE SYSTEM PDE NETWORK SWITCH SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 27-30-00-2.02.
- ③ SECURITY SYSTEM DIGITAL VIDEO RECORDER (DVR) SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 28-10-01-2.01.
- ④ SCADA RADIO SYSTEM SUPPLIED BY THE GOVERNMENT PER SPEC. SECTION 27-20-01-2.01A.
- ⑤ TELEPHONE SYSTEM MEDIA CONVERTER SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 27-30-00-2.03.
- ⑥ CABINET GROUND BAR (BOM 1.10A) INSTALLED IN THIS LOCATION AND IS MOUNTED AT THE INTERIOR BOTTOM OF THE RIGHT MOUNTING BRACKET OF THE RACK MOUNTED DIN RAIL PANEL. THIS GROUND BAR IS MOUNTED HORIZONTALLY FROM THE BACK TO THE FRONT OF THIS RIGHT MOUNTING BRACKET.

<b>ALWAYS THINK SAFETY</b> <small>U.S. GOVERNMENT OF THE INTERIOR                  BUREAU OF LAND MANAGEMENT                  HAWAII OILFIELD WATER SUPPLY PROJECT                  NEW WEZED                  SAN JUAN LATERAL                  TOHLAKAI PUMPING PLANT</small>		<b>RECLAMATION</b> <small>Managing Water to Be Wiser</small>	
YUKON & ASSOCIATES, LTD. CONSULTING ENGINEERS 1000 W. 10TH AVENUE, SUITE 100 ANCHORAGE, ALASKA 99501		SPEC. NO.: 28-0031 DRAWING TITLE: SCADA NETWORK CABINET INTERIOR FRONT RACK VIEW	
YUKON CUSTOMER: BAAI YUKON REV. DATE: 08/20/11	YUKON JOB: 625 YUKON REV: 493	YUKON DRAWING NUMBER: 140R4020C0013	YUKON SHEET #: 13
DATE: 08/20/11 TIME: 10:00 AM DRAWING: 140R4020C0013		SHEET: 13 OF 13	



GENERAL NOTES:

1. ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD WIRING INSTALLED BY OTHERS.

KEYED NOTES:

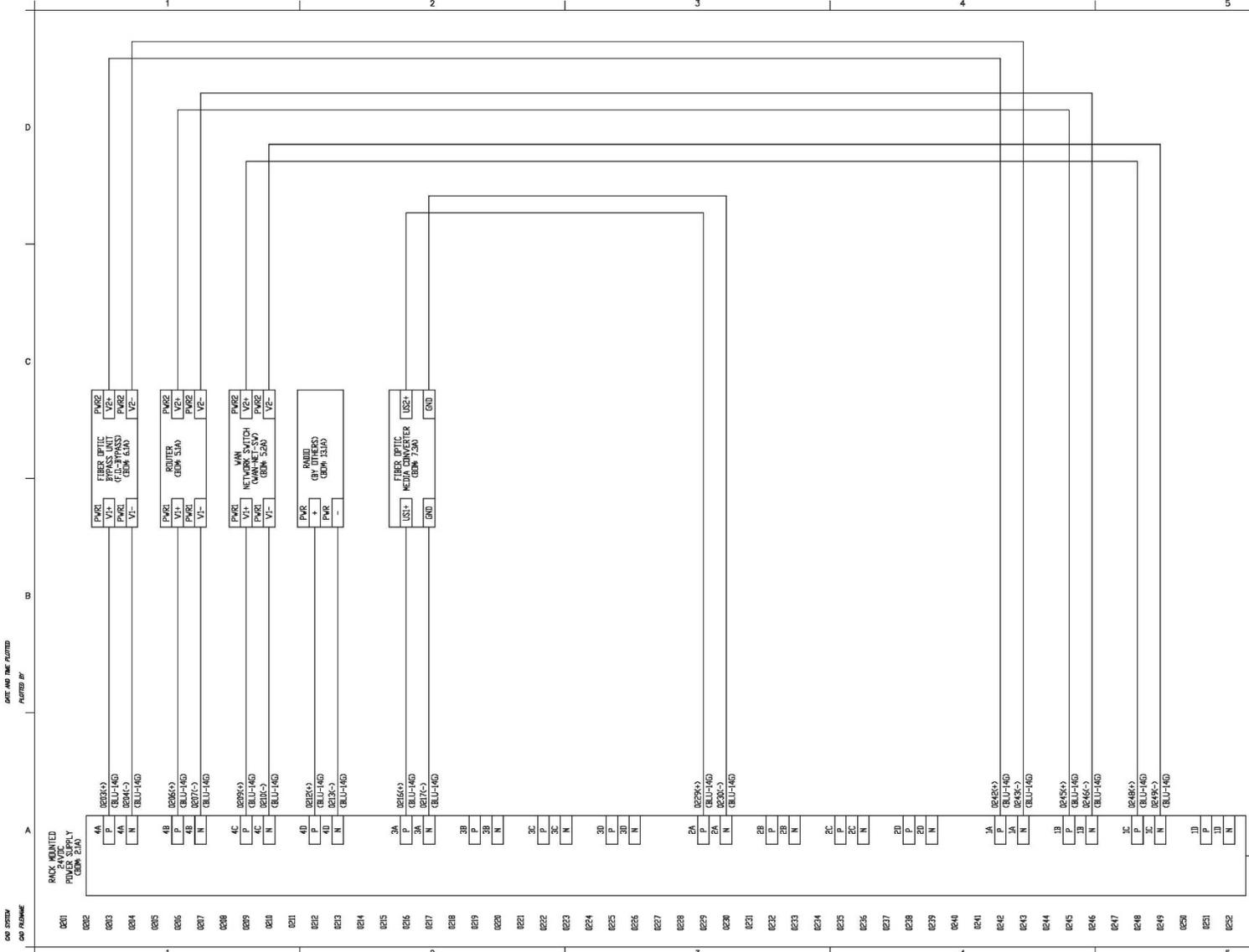
- ① TELEPHONE SYSTEM PDE NETWORK SWITCH SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 27-30-00-2.02.
- ② SECURITY SYSTEM DIGITAL VIDEO RECORDER (DVR) SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 28-10-01-2.01.
- ③ TELEPHONE SYSTEM MEDIA CONVERTER SUPPLIED & INSTALLED BY OTHERS PER SPEC. SECTION 27-30-00-2.03.

RECLAMATION  
*Managing Water in the West*

<b>YUKON &amp; ASSOCIATES, LTD.</b>	
CONTRACT NO.: 00013	SPEC. NO.: 28-0031
PROJECT TITLE:	SCADA NETWORK CABINET
CLIENT:	120VAC POWER DISTRIBUTION
YUKON CUSTOMER:	SAVA
YUKON JOB:	622
YUKON REV. DATE:	03/20/13
YUKON REV. BY:	ASB
YUKON DRAWING NUMBER:	YUKON SHEET #:
DESIGNED BY:	11

**ALWAYS THINK SAFETY**  
 THE DEPARTMENT OF THE INTERIOR  
 BUREAU OF LAND MANAGEMENT  
 ANAHO GULCH WATER SUPPLY PROJECT  
 NEW MEXICO  
 SAN JUAN LATERAL  
 TOHLAKAI PUMPING PLANT

DATE AND TIME PLANNED  
 PREPARED BY  
 SHEET 01 OF 01



ONE AND THE SAME  
 ONE AND THE SAME  
 PLATED BY

1 2 3 4 5

GENERAL NOTES:  
 1. ALL WIRES (LINES) THAT ARE DASHED REPRESENT FIELD WIRING INSTALLED BY OTHERS.

PLUGGED INTO UPPER ISOWAC RACK MOUNTED OUTLET STRIP  
 (SEE PREVIOUS SHEET)

SHEET OF	DATE: 2017-03-17	DRAWN: SUMITRA	ALWAYS THINK SAFETY U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT ANNAO GULLIP MOUNTAIN SUPPLY PROJECT NEW MEXICO SAN JUAN LATERAL TOHLAKAI PUMPING PLANT	YUKON & ASSOCIATES, LTD. 10000 100TH STREET, SUITE 100 YUKON, ALASKA 99757 YUKON CUSTOMER: MVI YUKON REV. DATE: 2017-03-17 YUKON DRAWING NUMBER: 140R4020C0013	RECLAMATION <i>Managing Water in the West</i> YUKON PROJECT NUMBER: 25-0000 YUKON DRAWING TITLE: SCADA NETWORK CABINET 24VDC POWER DISTRIBUTION YUKON JOB#: 02E YUKON REV: ASB YUKON SHEET #: 1E
				1E	

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

## **SECTION 52 00 00 DRAWINGS**

### **PART 1 GENERAL**

#### **1.01 DISCREPANCIES, ERRORS, OR OMISSIONS**

- A. Inform CO of discrepancies discovered on drawings in accordance with clause at FAR 52.236-21, Specifications and Drawings for Construction.
- B. In accordance with clause at FAR 52.236-21, Specifications and Drawings for Construction, in case of discrepancies, written specifications take precedence over drawings unless otherwise specified.

#### **1.02 PROJECT CONDITIONS**

- A. Where there are differences as determined by the CO between details and dimensions shown on drawings and details and dimensions of existing features at jobsite, use details and dimensions of existing features at jobsite.

#### **1.03 STANDARD DRAWINGS**

- A. Standard drawings may show details which are not a part of work under this contract. Disregard details shown on these drawings which are not applicable to work under this contract.

#### **1.04 COPIES OF DRAWINGS**

- A. One set of full-size (22 inches by 34 inches) drawings, except standard drawings, will be furnished to Contractor.
- B. Upon request, additional half-size (11 inches by 17 inches) copies of standard drawings will be furnished to Contractor.

#### **1.05 LIST OF DRAWINGS**

- A. Drawings listed in drawings 1695-D-60397 and 1695-D-60398, are made a part of Section C-Description/Specifications.

#### **1.06 DRAWING NUMBERS IN NUMERICAL ORDER**

- A. Specification drawings are listed in numerical order in Table 52 00 00A - Drawings in Numerical Order.

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-	
1695-D-60308	270
1695-D-60309	271
1695-D-60366	20
1695-D-60367	21
1695-D-60368	22
1695-D-60369	23
1695-D-60370	24
1695-D-60371	25
1695-D-60372	26
1695-D-60373	27
1695-D-60374	28
1695-D-60375	29
1695-D-60376	30
1695-D-60377	31
1695-D-60378	32
1695-D-60379	33
1695-D-60380	37
1695-D-60381	38
1695-D-60382	39
1695-D-60383	40
1695-D-60384	66
1695-D-60385	67
1695-D-60386	34
1695-D-60387	35
1695-D-60388	36
1695-D-60389	127

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60390	128
1695-D-60391	129
1695-D-60392	130
1695-D-60393	131
1695-D-60394	132
1695-D-60395	112
1695-D-60396	1
1695-D-60397	2
1695-D-60398	5
1695-D-60399	6
1695-D-60400	7
1695-D-60401	8
1695-D-60402	9
1695-D-60403	10
1695-D-60404	11
1695-D-60405	14
1695-D-60406	12
1695-D-60407	13
1695-D-60408	15
1695-D-60409	16
1695-D-60410	17
1695-D-60411	41
1695-D-60412	42
1695-D-60413	43
1695-D-60414	44
1695-D-60415	45
1695-D-60416	46

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60417	47
1695-D-60418	48
1695-D-60419	49
1695-D-60420	50
1695-D-60421	51
1695-D-60422	52
1695-D-60423	53
1695-D-60424	54
1695-D-60425	55
1695-D-60426	56
1695-D-60427	57
1695-D-60428	58
1695-D-60429	59
1695-D-60430	60
1695-D-60431	61
1695-D-60432	62
1695-D-60433	63
1695-D-60434	64
1695-D-60435	65
1695-D-60436	76
1695-D-60437	74
1695-D-60438	75
1695-D-60439	77
1695-D-60440	69
1695-D-60441	70
1695-D-60442	158
1695-D-60443	159

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60444	160
1695-D-60445	161
1695-D-60446	71
1695-D-60447	72
1695-D-60448	73
1695-D-60449	68
1695-D-60466	18
1695-D-60467	19
1695-D-60472	153
1695-D-60473	154
1695-D-60474	155
1695-D-60475	156
1695-D-60476	157
1695-D-60485	141
1695-D-60486	78
1695-D-60487	145
1695-D-60489	142
1695-D-60490	143
1695-D-60491	151
1695-D-60492	152
1695-D-60493	133
1695-D-60494	134
1695-D-60495	135
1695-D-60496	136
1695-D-60497	137
1695-D-60498	138
1695-D-60499	139

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60500	140
1695-D-60501	146
1695-D-60502	144
1695-D-60503	150
1695-D-60504	125
1695-D-60505	86
1695-D-60506	87
1695-D-60507	88
1695-D-60508	89
1695-D-60509	90
1695-D-60510	91
1695-D-60511	92
1695-D-60512	93
1695-D-60513	94
1695-D-60514	95
1695-D-60515	96
1695-D-60516	97
1695-D-60517	98
1695-D-60518	99
1695-D-60519	100
1695-D-60520	101
1695-D-60521	102
1695-D-60524	126
1695-D-60525	84
1695-D-60527	168
1695-D-60528	169
1695-D-60529	170

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60530	171
1695-D-60531	172
1695-D-60532	173
1695-D-60533	174
1695-D-60534	175
1695-D-60535	176
1695-D-60536	177
1695-D-60537	178
1695-D-60538	179
1695-D-60539	180
1695-D-60540	181
1695-D-60541	182
1695-D-60542	183
1695-D-60543	184
1695-D-60544	185
1695-D-60545	186
1695-D-60546	187
1695-D-60547	188
1695-D-60548	189
1695-D-60549	190
1695-D-60550	191
1695-D-60551	192
1695-D-60552	193
1695-D-60553	194
1695-D-60554	195
1695-D-60555	196
1695-D-60556	197

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60557	198
1695-D-60558	199
1695-D-60559	200
1695-D-60560	201
1695-D-60561	202
1695-D-60562	203
1695-D-60563	204
1695-D-60564	205
1695-D-60565	206
1695-D-60566	207
1695-D-60567	208
1695-D-60568	209
1695-D-60569	210
1695-D-60570	211
1695-D-60571	212
1695-D-60572	213
1695-D-60573	214
1695-D-60574	215
1695-D-60575	216
1695-D-60576	217
1695-D-60577	218
1695-D-60578	219
1695-D-60579	220
1695-D-60580	221
1695-D-60581	222
1695-D-60582	223
1695-D-60583	224

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60584	225
1695-D-60585	226
1695-D-60586	227
1695-D-60587	228
1695-D-60588	229
1695-D-60589	230
1695-D-60590	231
1695-D-60591	232
1695-D-60592	233
1695-D-60593	234
1695-D-60595	103
1695-D-60596	104
1695-D-60597	105
1695-D-60598	106
1695-D-60599	107
1695-D-60600	108
1695-D-60601	109
1695-D-60602	110
1695-D-60603	111
1695-D-60604	113
1695-D-60605	114
1695-D-60606	115
1695-D-60607	116
1695-D-60608	117
1695-D-60609	118
1695-D-60610	119
1695-D-60611	120

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60612	121
1695-D-60613	122
1695-D-60614	123
1695-D-60615	162
1695-D-60616	163
1695-D-60617	164
1695-D-60618	165
1695-D-60619	166
1695-D-60620	167
1695-D-60621	124
1695-D-60622	147
1695-D-60623	148
1695-D-60624	149
1695-D-60640	235
1695-D-60641	236
1695-D-60642	238
1695-D-60643	239
1695-D-60644	241
1695-D-60645	244
1695-D-60646	243
1695-D-60647	237
1695-D-60648	240
1695-D-60649	242
1695-D-60677	272
1695-D-60703	273
1695-D-60704	79
1695-D-60705	274

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
1695-D-60715	81
1695-D-60722	275
1695-D-60731	276
1695-D-60732	80
1695-D-60733	277
1695-D-60767	82
1695-D-60768	83
1695-D-60770	85
1695-529-	
1695-529-60146	4
1695-529-60222	3
40-D	
40-D-4334	245
40-D-4335	246
40-D-4753	247
40-D-5246	248
40-D-5247	249
40-D-5248	250
40-D-5249	251
40-D-5328	252
40-D-5599	253
40-D-6032	254
40-D-6137	255
40-D-6234	256
40-D-6376	257
40-D-6592	258
40-D-6601	259

Table 52 00 00B - Drawings in Numerical Order

Drawing No.	Sheet No.
40-D-6743	260
40-D-7016	261
40-D-7018	262
40-D-7102	263
40-D-60001	264
40-D-60002	265
40-D-60003	266
40-D-60004	267
104-529-	
104-D-254	268
104-D-757	269

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 53 10 00**  
**GEOLOGIC INVESTIGATIONS**

**PART 1      GENERAL**

**1.01      GENERAL**

- A. This section describes surface and subsurface conditions at both Pumping Plant No. 4 and Pumping Plant No. 7 project areas. Other sections of these specifications contain geological and geotechnical information important for understanding the significance of geologic conditions to construction operations.
- B. Geologic descriptions, drawings, logs of subsurface explorations, water level data, and test data in these specifications include information and records of geologic investigations for the work, and are the geologic data upon which design of this work is based. These data supersede previous versions which may be available for examination by Offerors. These data are contained in Section 53 20 00 – Records of Geologic and Subsurface Investigations.
- C. Unconsolidated soil materials recorded in geologic exploration logs included in these Specifications were classified under current Unified Soil Classification System procedures as described in USBR 5000 (laboratory classification) and USBR 5005 (visual classification). These two procedures are similar to ASTM D2487 and ASTM D2488, respectively.
- D. Reclamation has established standard descriptors and descriptive criteria for rock and standard descriptors and descriptive criteria for discontinuities. These standards are detailed on drawings 40-D-7022 and 40-D-7023 included in section 53 20 00 – Records of Geologic and Subsurface Investigations. Standards provide basis for classification and description of rock and discontinuities logged after September 1984.
- E. Geologic logs of drill holes, test pits, water-level data, and other available geologic information indicate conditions encountered during investigations. Water-level data show conditions at particular time or times information was obtained and may not indicate variations such as those caused by drought, precipitation, changes in surface elevation of nearby reservoirs, irrigation, or flooding.
- F. Geologic drawings portray generalized geologic conditions and do not depict local irregularities. Geologic logs of explorations should be consulted for specific details. For General Geologic Legend, Explanation, and Notes, refer to drawing number 1695-529-60086 for Pumping Plant No. 4 and drawing number 1695-529-60094 for Pumping Plant No. 7 in section 53 20 00 – Records of Geologic and Subsurface Investigations.
- G. Surface geology and location of explorations, cross sections, and note drawings for work are included in section 53 20 00 – Records of Geologic and Subsurface Investigations on

drawing Nos. 1695-529-60086, 1695-529-60057 and 1695-529-60083 for Pumping Plant No. 4 and on drawing Nos. 1695-529-60094, 1695-529-60059 and 1695-529-60084 for Pumping Plant No. 7.

- H. Selected samples recovered during investigations were tested by Reclamation's Four Corners Construction Office (FCCO) Laboratories in Farmington, New Mexico. Summaries of Physical Properties and Test Results from laboratory tests performed on these samples are contained in Section 53 20 00 – Records of Geologic and Subsurface Investigations. Offerors are encouraged to inspect the site and obtain their own samples and perform tests on the materials to evaluate properties which Offeror believes to be significant. Samples are available for examination at Reclamation's FCCO in Farmington, New Mexico. Offerors wishing to inspect the samples, visit the site, or take samples at the site should make arrangements with FCCO at telephone number (505) 324-5035.
- I. Additional laboratory testing was conducted by Reclamation Technical Service Center (TSC) Concrete Geotechnical and Structural Laboratory (CGSL) in Denver, Colorado. Offerors are encouraged to inspect the site and obtain their own samples and perform tests on the materials to evaluate properties which Offeror believes to be significant. Results of laboratory testing is available by contacting CGSL at telephone number (303) 445-2373.

## **1.02 REFERENCE STANDARDS**

- A. ASTM International (ATSM)
1. ASTM D2487-11 Classification of Soils for Engineering Purposes (Unified Soil Classification)
  2. ASTM D2488-09a Description and Identification of Soils (Visual-Manual Procedure)
  3. ASTM D7382-08 Determination of Maximum Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibrating Hammer.
- B. Bureau of Reclamation (USBR)
1. USBR EM – Earth Manual, Part 2, Third Edition (1990)
  2. USBR 5000-86 Determining Unified Soil Classification (Laboratory Method)
  3. USBR 5005-86 Determining Unified Soil Classification (Visual Method)
  4. USBR 7205 Determining Unit Weight of Soils In-place by the Sand-Cone Method
  5. Engineering Geology Field Manual, Second Edition (1998)

6. Copies of the above Reclamation procedures are available for review at Bureau of Reclamation, FCCO, 1235 LaPlata Highway, Farmington, New Mexico; or at the Technical Service Center, 6th and Kipling, Building 67, Room 1068, Denver, Colorado. Bidders wishing to inspect the reports and memoranda should make arrangements through the FCCO at (505) 325-1794.

### 1.03 REFERENCE REPORTS

~~A. Copies of the following reports and memoranda are available for review at Bureau of Reclamation, FCCO, 1235 LaPlata Highway, Farmington, New Mexico; or at the Technical Service Center, 6th and Kipling, Building 67, Room 1068, Denver, Colorado. Bidders wishing to inspect the reports and memoranda should make arrangements through the FCCO at (505) 325-1794:~~

- ~~1. Geologic Design Data Report, San Juan Lateral, Pumping Plant No. 4, NGWSP, Bureau of Reclamation, Upper Colorado Region, Four Corners Construction Office, Farmington, New Mexico, October 2016.~~
- ~~2. Technical Memorandum No. ZN-8314-4, Pumping Plant No. 4—Geotechnical Design, Navajo-Gallup Water Supply Project San Juan Lateral, New Mexico, 2018.~~
- ~~3. Geologic Design Data Report, San Juan Lateral, Pumping Plant No. 7, NGWSP, Bureau of Reclamation, Upper Colorado Region, Four Corners Construction Office, Farmington, New Mexico, September 2016.~~
- ~~4. Technical Memorandum No. ZN-8314-5, Pumping Plant No. 7—Geotechnical Design, Navajo-Gallup Water Supply Project San Juan Lateral, New Mexico, 2018.~~

A. Section 53 30 00 – Design Data Report Pumping Plant 4.

B. Section 53 40 00 – Pumping Plant 4 Geotechnical Design.

C. Section 53 50 00 – Geological Design Data Report – San Juan Lateral, Pumping Plant 7.

D. Section 53 60 00 – Pumping Plant 7 – Geotechnical Design.

### 1.04 GEOLOGIC INVESTIGATIONS

A. Geologic investigations conducted at Pumping Plant No. 4 and Pumping Plant No. 7 include drill holes, test pits, surface geologic mapping, field and laboratory testing. Geologic investigations are listed below; and available logs of investigations are contained in Section 53 20 00 - Records of Geologic and Subsurface Investigations:

1. Drill holes were conducted by Reclamation Upper Colorado and Great Plains Region Drill Crews. Drilling was conducted using a CME 85 truck mounted drill rig. Continuous core sampling in soils was conducted using a 4.25-inch diameter by 5-foot long flight auger dry core sampler. Core drilling in rock was conducted using an HQ3 wireline rock coring system with a 2.5-inch diameter split tube

sampler. Drill hole testing utilized Standard Penetration Test (SPT) and California Sampler method:

- a. Standard Penetration Testing (SPT) was conducted using a 4.25-inch diameter by 5-foot-long hollow stem auger with a split tube type sampler and a 1.5-inch inside diameter by 2.5-foot-long SPT sampler. A 140-pound auto hammer was used to drive sampler. SPT sampler was advanced 1.5-feet with blow counts reported per 0.5-foot of advancement.
  - b. California Sampler had a 2.5-inch outside, 2-inch inside diameter, with three to four, 4-inch x 1.94-inch brass liners. Central barrel was 16-inches in length. A 140-pound auto hammer was used to drive sampler. Sampler was seated with two to three blows, where seated depth was recorded. After seating, blow counts were recorded for every 0.5-foot of advancement. Sampler was advanced 1.0-foot for each test and bottom two brass liners (A and B) were capped, sealed with tape and labeled for laboratory testing. A third brass liner (C) was occasionally recovered and sent for testing.
2. Test pits were conducted by FCCO geology group with backhoe operator and laboratory personnel. Test pits were excavated using a Deere 310J backhoe with a 24-inch-wide bucket. Test pits were excavated to limits of reach of equipment or refusal to advance.
- B. The following are geologic investigations performed at Pumping Plant No. 4. Geologic surface mapping at a scale of 1-inch to 100-feet was performed in 2014. Subsurface investigations began in 2016 and consisted of six test pits (TPSTR7-16-1 through TPSTR7-16-6) and nineteen drill holes (DHSTR7-16-1 through DHSTR7-16-18 and DHPP4-16-6):
1. An in-place density was performed in test pit TPSTR7-16-2. In-place densities were not performed in all test pits because of oversized materials encountered in the pediment deposit. Results from in-place density is shown on test pit logs in section 53 20 00 – Records of Geologic and Subsurface Investigations.
  2. Samples from tank and pumping plant site were collected at a depth of 10-feet below ground surface and sent to TSC CGSL for corrosion testing to be used for concrete, steel pipe and cathodic protection design. Information regarding swell and corrosion testing are summarized in Technical Memorandum No. ZN-8314-4 Pumping Plant No. 4 – Geotechnical Design, Navajo-Gallup Water Supply Project San Juan Lateral, New Mexico, 2018 available by contacting Reclamation TSC, Concrete Geotechnical and Structural Laboratory (CGSL).
- C. The following are geologic investigations that were performed at Pumping Plant No. 7. Geologic surface mapping at a scale of 1-inch to 100-feet was performed in 2014. Subsurface investigations began in 2016 and consisted of eight test pits (TPPP7-16-1 through TPPP7-16-8) and eleven drill holes (DHPP7-16-1 through DHPP7-16-11).
- D. Ground water was encountered in several drill holes and a monitoring well was installed in DHPP7-16-3 to measure ground water elevation.

- E. In-place densities were taken in test pits TPPP7-16-6 at 6.0-feet and TPPP7-16-8 at 7.0-feet. Results from in-place densities are shown on test pit logs in section 53 20 00 – Records of Geologic and Subsurface Investigations.
- F. Corrosion samples from tank and pumping plant site were collected at 4-feet below ground surface and sent to TSC for corrosion testing for concrete, steel pipe and cathodic protection design. Information regarding swell and corrosion testing are summarized in Technical Memorandum No. ZN-8314-5, Pumping Plant No. 7 – Geotechnical Design, Navajo Gallup Water Supply Project San Juan Lateral, New Mexico, 2018 available by contacting Reclamation TSC, Concrete Geotechnical and Structural Laboratory (CGSL).

## 1.05 REGIONAL GEOLOGY

- A. The San Juan Basin is a broad basin surrounded by many mountain ranges with distinct geologies, including the Chuska Mountains, La Plata Mountains, San Juan Mountains, San Pedro Mountains, Zuni Mountains, and Mount Taylor. Characterized by plateaus, mesas and dry-wash canyons presently being eroded in an arid climate, the San Juan Basin is a structural depression and contains Quaternary and Tertiary alluvium, resting on rocks of Tertiary and Cretaceous age which crop out around the margins of the basin. The NGWSP San Juan Lateral is located east of the Chuska Mountains, near the southwestern margin of the basin north of Gallup, New Mexico. The eastern slope of the Chuska Mountains varies from many types of alluvium to mudflats. Bedrock units which outcrop along this portion of the San Juan Lateral are the Cretaceous Menefee Formation. Bedrock is typically covered on the surface by varying amounts of surficial deposits mapped on the surface as Quaternary age Alluvium and Pediment. Menefee Formation sandstone generally forms cap rock on hill tops and softer claystone and shale units form lower slopes on hills.

## 1.06 SITE GEOLOGY

- A. Pumping Plant No. 4:
  - 1. Pumping Plant No. 4 is located on a pediment that is relatively flat on top and flanked by steep, erosional escarpments, often filled with Quaternary Alluvium deposits (Qal). The pediment is comprised of Quaternary pediment deposits (Qpd overlying the Cretaceous Menefee Formation (Kmf) bedrock.):
    - a. Quaternary Alluvium (Qal):
      - 1) Quaternary Alluvium are soils that overlie bedrock in valleys surrounding investigation site of Pumping Plant No. 4. Alluvium sampled in the valley is visually classified as Clayey Sand (SC). Soils are generally fine grain sands with variable amounts of plastic to non-plastic fines and occasionally contain gravel or cobbles. Quaternary Alluvium was only encountered in DHPP4-16-6 located on the south slope of the pediment from 0- to 3.0-feet of depth. Quaternary Alluvium is used to describe these surficial deposits regardless of origin. The alluvium is derived from a variety of sources including slope wash, eolian and alluvial

deposition as well as weathering and decomposition of in-place claystone bedrock.

b. Quaternary Pediment Deposits (Qpd):

- 1) Pediment deposits are found on top of the sloped, erosional surface of the Cretaceous Menefee Formation within the project area. These deposits originate primarily from the Chuska Mountains west of the project area. The pediment deposit is a veneer of alluvial material and consist of various amounts of clay and silt, sand, angular to rounded gravel and cobbles and often contain angular to rounded boulders. The material is generally described as Cobbles and Boulders with soils depending on composition. Lenses of soils range from Silty Sand (SM) to Silty Sand with Gravel (SM)g, Lean Clay (CL) and Sandy Lean Clay s(CL), Silt with Sand (ML)s and Sandy Silty Clay s(CL-ML), Silty Gravel with Sand (GM)s, Clayey Sand (SC) to Poorly Graded Sand with Silt (SP-SM) that may contain gravel. Material with oversize particles (greater than 3-inches) is described using the USCS and are classified as Silty Sand with Gravel, Cobbles and Boulders (SM)gcb, Clayey Sand With Gravel, Cobbles and Boulders (SC)gcb, Poorly Graded Sand with Silt, Gravel, Cobbles and Boulders (SP-SM)gcb and Poorly Graded Gravel with Sand, Cobbles and Boulders (GP)scb. Material having a majority of oversize particles are referred to as Cobbles and Boulders. The gravel, cobbles and boulders are composed of hard sandstone with a trace of hard, basalt, quartzite, chert and petrified wood. Quaternary Pediment Deposits were encountered at all of the drill holes and test pits with the exception of DHPP4-16-6 located on the south slope of the pediment. Quaternary Pediment deposits ranged from 12.6-feet thick in DHSTR7-14-6 up to 33.6-feet thick in DHSTR7-16-14 located in the pumping plant foundation.

c. Cretaceous Menefee Formation (Kmf):

- 1) Cretaceous Menefee Formation at Pumping Plant No. 4 consists primarily of light to dark gray claystone with interbedded shale, sandstone, and coal seams. Claystone is generally soft and moderately weathered but can be very soft and very intensely weathered to decomposed. Claystone has carbonaceous laminations, can be thinly bedded and grades to shale and coal. Claystone can be classified as Lean Clay (CL) and as Fat Clay (CH) when it is processed through laboratory methods. Shale is brown to black and is generally moderately soft and slightly to moderately weathered but can be soft. Shale is thinly bedded with coal laminations, grades to coal and is fissile and friable. Coal units encountered are dark brown to black, soft and moderately to slightly weathered. Sandstone units are fine grained, brownish orange to gray in color and vary from hard to soft. Weathering of

the sandstone ranges from moderately weathered to slightly weathered. Sandstone outcrops are mapped on the pediment escarpment and were encountered in subsurface investigation in drill hole DHSTR7-16-12 at 31.8-feet and in drill hole DHPP4-16-6 at 24.5-feet below ground surface. Coal can be laminated to thinly bedded, is brittle and has a dull luster. Gypsum and iron oxide staining is present in most bedrock units sampled. The bedrock locally has a shallow dip toward the northeast.

B. Pumping Plant No. 7:

1. Pumping Plant No. 7 is located on a broad, low-lying alluvial valley known as Tohatchi Flats. This depositional environment is primarily floodplain. The high mountains and low-relief channel seasonal runoff to small drainages and larger washes creating a setting that facilitates flooding and scour. The geologic units encountered at the Pumping Plant No. 7 footprint consists of Quaternary Alluvium (Qal) on Cretaceous Menefee Formation (Kmf) bedrock.
  - a. Quaternary Alluvium (Qal):
    - 1) Quaternary Alluvium deposits overlie bedrock at Pumping Plant No. 7 site and was encountered at the ground surface in all drill hole and test pit explorations. Thickness of alluvium ranged from 2.6-feet thick in DHPP7-16-8 up to 11.3-feet thick in DHPP7-3. Alluvial soils range from Silty Sand (SM), Silty Clayey Sand (SC-SM), to Clayey Sand (SC) and Sandy Lean Clay s(CL). Quaternary Alluvium is used to describe all surficial deposits regardless of origin. Alluvium is derived from a variety of sources including eolian and alluvial deposition as well as weathering and decomposition of in-place sandstone and claystone bedrock.
  - b. Cretaceous Menefee Formation (Kmf):
    - 1) Cretaceous Menefee Formation consists primarily of light brown, fine-grained sandstone with interbedded claystone, shale and siltstone but can vary in color and grain size. Bedrock locally has a shallow dip toward the northeast. Sandstone can be decomposed but is generally moderately weathered, moderately soft to soft and slightly fractured at the surface. The same sandstone unit, when excavated below ground level, can be moderately hard and slightly weathered. A hard, iron rich, calcareous sandstone is occasionally inter-bedded within the softer sandstone units. This inter-bedded sandstone is hard and can only be broken by a heavy hammer blow. Claystone is sandy, light brown to dark gray in color and is generally laminated to thinly bedded. Claystone ranges from moderately to slightly weathered too intensely to moderately weathered and soft to very soft. Claystone often grades to siltstone and occasionally becomes fissile, grading to shale. Claystone

intervals encountered ranged from a few inches to 5-feet in thickness.

## **1.07 GROUNDWATER**

- A. Water level data show the conditions at particular time or times information was obtained and may not indicate variations such as those caused by periods of drought, increased rainfall, seasonal fluctuations in precipitation, or application of irrigation water.
- B. Sand washes and tributary streams in project area may have intermittent surface water flow particularly after rainfall. Surface flow would have an adverse effect on excavation and construction activities. Surface flow is likely to increase groundwater elevation in surrounding areas and would likely increase groundwater elevations in areas that are dry when streams do not have flowing surface water.
- C. Groundwater was encountered in geologic explorations at Pumping Plant No. 7 site. Groundwater was encountered in drill holes DHPP7-16-3 at 30.7-feet of depth measured in July 2016. DHPP7-16-2 encountered groundwater at 29.8-feet of depth, DHPP7-16-5 and DHPP7-16-11 both encountered groundwater at 31.5-and 39.0-feet respectively in April 2016. A small area approximately 300-feet northeast of the proposed foundation may pond water during precipitation events.
- D. Groundwater was not encountered in any geologic explorations at Pumping Plant No. 4 site. However; perched water tables could be encountered along claystone and shale bedrock surfaces. Additional ground and surface water should be expected after extensive rainfall and snowmelt.

## **1.08 ENGINEERING GEOLOGY AND GEOTECHNICAL CONSIDERATIONS**

- A. Temporary and permanent cut slopes and slope stability: All cut slopes shall be constructed in accordance with Reclamation Safety and Health Standards and OSHA standards. Recommendations are for dry or adequately drained materials. These recommendations are for all slopes with a vertical height of less than 20-feet. Slopes with a vertical height of 20-feet or greater should be designed by a registered professional engineer in accordance with Reclamation Safety and Health Standards and OSHA standards. Materials with excessive moisture will require further flattening for stability or other slope stability measures:
  - 1. Temporary and permanent slopes excavated in fill, soil, and bedrock shall conform to OSHA slope requirements.
  - 2. Other specification sections detail slope requirements and shall be used for construction of pipeline and structures.

B. Excavation considerations:

1. Soil and fill can be excavated using common excavation methods.
2. Decomposed to intensely weathered sandstone, and decomposed to moderately weathered claystone and siltstone can be excavated using common methods. Less weathered sandstone, claystone and siltstone layers may require rock excavation methods. Local, hard, moderately or less weathered zones and cemented zones may be encountered within decomposed and weathered bedrock. These zones are likely to require rock excavation methods. Excavation of these zones may generate larger blocks that may have to be reduced to a manageable size by hydraulic hoe-ram, mechanical splitting, or other non-explosive methods.
3. Excavation of bedrock in confined areas with limited access for ripping with a bulldozer and single ripper shank may require rock excavation methods (such as excavation with a hydraulic hoe-ram).

C. Constructability considerations:

1. Access roads may become muddy and excessively slick with rain, surface run-off, or water applied for construction.
2. Expansive soils have been encountered during geologic investigations. Expansive or other potentially problematic soils may require mixing or other processing as approved by COR.

**END OF SECTION**

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**SECTION 53 20 00**  
**RECORDS OF GEOLOGIC AND SUBSURFACE INVESTIGATIONS**

**PART 1 GENERAL**

**1.01 GEOLOGY DRAWINGS**

- A. Some drawings are in color to highlight geologic information. Geologic information shown on drawings is of equal importance regardless of whether or not it is highlighted.

Geology Drawings

Sheet No.	Drawing No.	Title
G1	103-D-347	Unified Soil Classification – Including Identification and Description
G2	40-D-7022	Geology for Design & Specifications, Standard Descriptors and Descriptive Criteria for Rock
G3	40-D-7023	Geology for Design & Specifications, Standard Descriptors and Descriptive Criteria for Discontinuities
G4	1695-529-60063	San Juan Lateral Pumping Plant No. 4, Location Map
G5	1695-529-60086	San Juan Lateral Pumping Plant No. 4, General Geologic Legend, Explanation, and Notes
G6	1695-529-60057	San Juan Lateral Pumping Plant No. 4, Surface Geology and Location of Exploration
G7	1695-529-60083	San Juan Lateral Pumping Plant No. 4, Geologic Sections A-A' and B-B'
G8	1695-529-60064	San Juan Lateral Pumping Plant No. 7, Location Map
G9	1695-529-60094	San Juan Lateral Pumping Plant No. 7, General Geologic Legend, Explanation, and Notes
G10	1695-529-60059	San Juan Lateral Pumping Plant No. 7, Surface Geology and Location of Exploration
G11	1695-529-60084	San Juan Lateral Pumping Plant No. 7, Geologic Sections A-A' and B-B'

## 1.02 GEOLOGIC LOGS

### Geologic Logs

Sheet No.	Title
Drill Holes Pumping Plant No. 4	
G12	DHSTR7-16-1
G13	DHSTR7-16-2
G14	DHSTR7-16-3
G15	DHSTR7-16-4
G16	DHSTR7-16-5
G17	DHSTR7-16-6
G18	DHSTR7-16-7
G19	DHSTR7-16-8
G20	DHSTR7-16-9
G21	DHSTR7-16-10
G22	DHSTR7-16-11
G23	DHSTR7-16-12
G24	DHSTR7-16-13
G25	DHSTR7-16-14
G26	DHSTR7-16-15
G27	DHSTR7-16-16
G28	DHSTR7-16-17
G29	DHSTR7-16-18
G30	DHPP4-16-6
Drill Holes Pumping Plant No. 7	
G31	DHPP7-16-1
G32	DHPP7-16-2
G33	DHPP7-16-3
G34	DHPP7-16-3 well completion diagram
G35	DHPP7-16-4

## Geologic Logs

Sheet No.	Title
G36	DHPP7-16-5
G37	DHPP7-16-6
G38	DHPP7-16-7
G39	DHPP7-16-8
G40	DHPP7-16-9
G41	DHPP7-16-10
G42	DHPP7-16-11
Test Pits Pumping Plant No. 4	
G43	TPSTR7-16-1
G44	TPSTR7-16-2
G45	TPSTR7-16-3
G46	TPSTR7-16-4
G47	TPSTR7-16-5
G48	TPSTR7-16-6
Test Pits Pumping Plant No. 7	
G49	TPPP7-16-1
G50	TPPP7-16-2
G51	TPPP7-16-3
G52	TPPP7-16-4
G53	TPPP7-16-5
G54	TPPP7-16-6
G55	TPPP7-16-7
G56	TPPP7-16-8

**1.03 LABORATORY TEST DATA**

## Laboratory Test Data

Sheet No.	Title
Laboratory Test Data for Drill Holes and Test Pits Pumping Plant No. 4	
G57	Summary of Physical Properties Test Results, DHSTR7-16-1 SPT#1, DHSTR7-16-1 SPT#2, DHSTR7-16-2 SPT#1, DHSTR7-16-3 SPT#1, DHSTR7-16-3 SPT#2, DHSTR7-16-4 SPT#1, DHSTR7-16-4 SPT#2, DHSTR7-16-4 SPT#3 and DHSTR7-16-4 SPT#4
G58	Summary of Physical Properties Test Results, DHSTR7-16-7 SPT#1, DHSTR7-16-7 SPT#2, DHSTR7-16-7 SPT#3, DHSTR7-16-8 SPT#1, DHSTR7-16-9 SPT#1, DHSTR7-16-9 SPT#2, DHSTR7-16-10 SPT#1, DHSTR7-16-10 SPT#2, DHSTR7-16-12 SPT#1 and DHSTR7-16-12 SPT#2
G59	Summary of Physical Properties Test Results, DHSTR7-16-13 SPT#1, DHSTR7-16-13 SPT#2, DHSTR7-16-13 SPT#3, DHSTR7-16-14 SPT#1 and TPSTR7-16-2
Laboratory Test Data for Drill Holes and Test Pits Pumping Plant No. 7	
G60	Summary of Physical Properties Test Results, DHPP7-16-1 SPT#1, DHPP7-16-2 SPT#1, DHPP7-16-3 SPT#1, DHPP7-16-3 SPT#2, DHPP7-16-4 SPT#1, DHPP7-16-5 SPT#1 and DHPP7-16-5 SPT#2
G61	Summary of Physical Properties Test Results, DHPP7-16-6 SPT#1, DHPP7-16-6 SPT#2, DHPP7-16-6 SPT#3, DHPP7-16-6 SPT#4, DHPP7-16-6 SPT#5, DHPP7-16-7 SPT#1, DHPP7-16-8 SPT#1, DHPP7-16-9 SPT#1, DHPP7-16-9 SPT#2 and DHPP7-16-10 SPT#1
G62	Summary of Physical Properties Test Results, DHPP7-16-11 SPT#1, DHPP7-16-11 SPT#1, DHPP7-16-11 SPT#2, DHPP7-16-11 SPT#3, TPPP7-16-6 and TPPP7-16-8

**END OF SECTION**

**SECTION 53 30 00**  
**GEOLOGIC DESIGN DATA REPORT SAN JUAN LATERAL, PUMPING PLANT 4**

# RECLAMATION

*Managing Water in the West*

## **GEOLOGIC DESIGN DATA REPORT**

### **SAN JUAN LATERAL, PUMPING PLANT 4**



### **NAVAJO GALLUP WATER SUPPLY PROJECT**



Department of the Interior  
Bureau of Reclamation  
Upper Colorado Region  
Four Corners Construction Office  
Farmington, New Mexico



*October 2016*

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**APPENDIX 1**

LOGS OF EXPLORATION

Drill Holes:

DHSTR7-16-1, DHSTR7-16-2, DHSTR7-16-3, DHSTR7-16-4, DHSTR7-16-5, DHSTR7-16-6, DHSTR7-16-7, DHSTR7-16-8, DHSTR7-16-9, DHSTR7-16-10, DHSTR7-16-11, DHSTR7-16-12, DHSTR7-16-13, DHSTR7-16-14, DHSTR7-16-15, DHSTR7-16-16, DHSTR7-16-17, DHSTR7-16-18, DHPP4-16-6.

Test Pits:

TPSTR7-16-1, TPSTR7-16-2, TPSTR7-16-3, TPSTR7-16-4, TPSTR7-16-5, TPSTR7-16-6.

**APPENDIX 2**

LABORATORY DATA

**APPENDIX 3**

PHOTOGRAPHS

**APPENDIX 4**

DRAWINGS

Dwg No. 1695-529-60095 General Map

Dwg No. 1695-529-60063 Location Map

Dwg No. 1695-529-60086 General Geologic Legend, Explanation and Notes

Dwg No. 1695-529-60057 Surface Geology and Location of Exploration

Dwg No. 1695-529-60083 Geologic Sections A-A' and B-B'

## **1.0 INTRODUCTION**

The Navajo-Gallup Water Supply Project (NGWSP) is a major infrastructure project that once constructed, will convey a reliable municipal and industrial water supply from the San Juan River to the eastern section of the Navajo Nation, southwestern portion of the Jicarilla Apache Nation and the city of Gallup, New Mexico. Approximately 280 miles of pipeline, several pumping plants and two water treatment plants are anticipated to be constructed. The NGWSP is divided into two segments, the Eastern phase (Cutter Lateral) and a Western phase (San Juan Lateral).

The subject of this report is located on the San Juan Lateral that is divided into several reaches. Pumping Plant 4 is located between Reach 7 and Reach 8 of the pipe alignment. The pumping plant will help deliver municipal water to the city of Gallup and surrounding Navajo Chapters.

### **1.1 PURPOSE**

The purpose of this report is to summarize geologic design data investigations for Pumping Plant 4 that is a feature of the NGWSP. Investigations were performed to collect site specific design data for potential buildings, line pipe and water tank foundations. Testing was requested by the Technical Service Center (TSC) to characterize foundation conditions with emphasis on identifying, sampling and testing potentially expansive foundation material. This report presents the data collected from February 2016 through August of 2016 from subsurface explorations and geologic mapping.

### **1.2 PROPOSED STRUCTURES**

Proposed structures at Pumping Plant 4 include a pumping plant, chlorine and air chamber buildings, two storage tanks, two chlorination vaults along with a valve and a flowmeter vault. Pumping Plant 4 will facilitate downstream distribution to subsequent reaches and pumping plants.

### **1.3 TOPOGRAPHICAL DATA BASE**

Aerial photography was flown in April 6<sup>th</sup> 2010 by Woolpert Inc. GPS survey equipment was used by Reclamation survey crews to locate panel points and the area was flown from

approximately 3,600 feet. The topography collected from Woolpert Inc. consists of 2-foot contours using NAD-83 datum. Test pits and drill holes from investigations were located using the Four Corners Construction Office (FCCO) survey crew utilizing survey quality GPS instruments. The coordinates are expressed in 1983 State Plane, New Mexico, West Zone.



Illustration of the geologic units as they are observed looking south in subsurface investigations.

Image for reference only.

Photo taken on 6/15/2016 by J. Gilbert.

## 2.0 GEOLOGIC INVESTIGATIONS

Geologic surface mapping at a scale of 1 inch to 100 feet was performed in 2014. Subsurface investigations began in 2016 and consisted of six test pits (TPSTR7-16-1 through TPSTR7-16-6) and nineteen drill holes (DHSTR7-16-1 through DHSTR7-16-18 and DHPP4-16-6). Drill holes were conducted by the FCCO geology group, the Reclamation Upper Colorado and Great Plains Drill Crews. Drill hole testing utilized the Standard Penetration Test (SPT) for soil classification

and the California Sampler method to extract samples for consolidated swell testing. Test pits were conducted by the FCCO geology group with a backhoe operator and laboratory personnel. Samples were collected for corrosion and cathodic protection in test pits and sent to the TSC for design purposes. Geologic logs, lab results, drawings and photos along with exploration data summary tables are included in this report.

## **2.1 TESTING AND SAMPLING**

All soils recovered from test pits and drill holes were logged and visually classified using methods described in USBR 5005 [Earth Manual, Part 2, Third Edition, and the Unified Soil Classification System (USCS)]. Testing conducted by the FCCO Materials Laboratory included in-place density, Proctor, Atterburg Limits, specific gravity, gradation analysis and laboratory soil classification.

Drilling was achieved using a CME 85 truck mounted drill rig. Standard Penetration Testing was conducted using a 4.25 inch diameter by 5 foot-long hollow stem auger with a split tube type sampler and a 1.5 inch inside diameter by 2.5 foot-long SPT sampler. A 140 pound auto hammer was used to drive the sampler. The SPT sampler was advanced 1.5 feet with blow counts reported per 0.5 foot of advancement. Representative samples were sent to the FCCO Materials Laboratory for laboratory soil classification. Bulk samples were collected from auger cuttings of alluvium and claystone and sent to the TSC for laboratory testing. All rock core recovered from the drill holes were visually classified using methods described in the USBR, Engineering Geology Field Manual, Second addition, Volume 1. Drill hole logs are included in Appendix 1.

The California Sampler had a 2.5 inch outside, 2 inch inside diameter, with three to four, 4 inch x 1.94 inch brass liners. The central barrel was 16 inches in length. Samples were extracted at depths specified in the Field Exploration Request for the purpose of consolidated swell testing. A 140 pound auto hammer was used to drive the sampler. The sampler was seated with two to three blows, where the seated depth was recorded. After seating, blow counts were recorded for every 0.5 foot of advancement. The sampler was advanced 1.0 foot for each test and the bottom two brass liners (A and B) were capped, sealed with tape and labeled for laboratory testing. The third brass liner C was occasionally recovered and sent for testing. All suitable samples were

carefully packaged and kept inside to prevent freezing. The samples were sent to the TSC laboratory for the consolidated swell test. Soils recovered from the brass liners were logged and visually classified using methods described in USBR 5005.



Typical shale and claystone units of the Menefee Formation recovered from drill holes.  
Image for reference only. Photo taken on 4/14/2016 by C. Beyer.

Test pits were excavated using a Deere 310J backhoe with a 24 inch bucket. Excavation, testing and sampling was performed to the limit of the equipment or refusal. Soil testing was conducted by the FCCO Materials Laboratory. An in-place density was performed in test pit TPSTR7-16-2. In-place densities were not performed in all test pits because of the oversized materials encountered in the pediment deposit. Results from the in-place density is shown on the test pit log in Appendix 1 and is included on the summary of test results in Appendix 2 and Table 2.



**Excavation of cobbles and boulders in test pit TPSTR7-16-5.  
Image for reference only.**

**Photo taken 8/3/2016 by J. Gilbert.**

Samples from the tank and pumping plant site were collected near 10 feet below ground surface and sent to the TSC for corrosion testing for concrete, steel pipe and cathodic protection design. Testing will determine if excavation spoils of the soil and rock from the water tank and building foundations may be suitable as engineered backfill. Information regarding the swell and corrosion testing are available by contacting Reclamation TSC, Concrete Geotechnical and Structural Laboratory (CGSL).

TABLE 1: SUMMARY OF DRILL HOLE INVESTIGATIONS

DRILL HOLES											
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA								BLOWS/0.5 (feet)	
		DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE		
DHSTR7-16-1 Site Investigation	0.0-17.9: (SP-SM)gc (Qpd)	18.0-19.0	Sample not Preserved								16/20
		20.5-22.0	SM	40	60	0	NA	NP	2.8	17/25/22	
		23.0-24.5	SM	34	66	0	NA	NP	2.8	12/19/28	
	17.9-22.7: SP-SM (Qpd)	28.0-29.0	California Sample								14/23
	22.7-26.2: SM(Qpd)	30.5-31.5	California Sample								31/37
		33.0-34.0	California Sample								30/50
	26.2-30.0: CLSTNE (Kmf)	35.5-36.5	California Sample								46/50
		38.0-39.0	California Sample								27/50
	30.0-45.0: SHALE (Kmf)	40.5-41.5	California Sample								Refusal
		43.0-44.0	California Sample								Refusal
DHSTR7-16-2 Site Investigation	0.0-11.0: (SP-SM)gc (Qpd)	13.0-14.5	(CL)s	80	18	2	39	22	6.8	11/16/19	
		18.0-19.0	California Sample								18/30
	11.0-13.8: SP-SM (Qpd)	23.0-24.0	California Sample								20/50
		28.0-29.0	California Sample								40/50
	13.8-35.2: CLSTNE (Kmf)	33.0-34.0	California Sample								50/NA
		38.0-39.0	California Sample								38/50
	35.2-45.0: SHALE (Kmf)	43.0-44.0	California Sample								Refusal
DHSTR7-16-3 Site Investigation	0.0-17.7: (SP-SM)gc (Qpd)	18.0-19.5	SM	39	54	7	NA	NP	3.2	11/21/26	
		20.5-22.0	SM	19	70	11	NA	NP	2.2	14/27/30	
	17.7-23.5: SP-SM (Qpd)	25.5-26.5	California Sample								18/35
		28.0-29.0	California Sample								16/28
	23.5-33.0: CLSTNE (Kmf)	30.5-31.5	California Sample								29/47
		33.0-34.0	California Sample								33/50
	33.0-35.0: SHALE (Kmf)	35.5-36.5	California Sample								24/50
		38.0-39.0	California Sample								Refusal
	35.0-35.9: COAL (Kmf)	40.5-41.5	California Sample								Refusal
	35.9-45.0: SHALE (Kmf)	43.0-44.0	California Sample								Refusal

DRILL HOLES										
EXPLORATION AND LOCATION	VISUAL, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA							BLOWS/0.5 (feet)	
		DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX		% MOISTURE
DHSTR7-16-4 Site Investigation	0.0-14.5: (SP-SM)gc (Qpd)	13.0-14.5	(SM)g	16	55	29	NA	NP	1.5	20/41/34
		15.5-17.0	SM	35	63	2	NA	NP	2.2	8/16/21
	14.5-22.4: SM (Qpd)	18.0-19.5	SM	25	62	13	NA	NP	2.5	30/40/49
		20.5-22.0	SM	31	61	8	NA	NP	2.7	11/17/20
	22.4-34.0: CLSTNE (Kmf)	23.0-24.0	California Sample							14/19
		28.0-29.0	California Sample							18/23
	34.0-45.0: SHALE (Kmf)	33.0-34.0	California Sample							Refusal
		38.0-39.0	California Sample							Refusal
		42.0-43.0	California Sample							Refusal
		20.5-20.5	California Sample							9/13
DHSTR7-16-5 Tank Site	0.0-2.5: SM (Qpd)	23.0-24.0	California Sample							11/16
		25.5-26.5	California Sample							20/40
	2.5-18.0: (SP-SM)gc (Qpd)	28.0-29.0	California Sample							18/28
		30.5-31.5	California Sample							40/50
	18.0-32.5: CLSTNE (Kmf)	33.0-34.0	California Sample							34/50
		35.5-36.5	California Sample							30/50
	32.5-45.0: SHALE (Kmf)	38.0-39.0	California Sample							49/50
		40.5-41.5	California Sample							Refusal
		43.0-44.0	California Sample							Refusal
		13.0-14.0	California Sample							28/27
DHSTR7-16-6 Site Investigation	0.0-12.6: (GP)sc (Qpd)	15.5-16.5	California Sample							19/27
		18.0-19.0	California Sample							15/29
	12.6-35.0: CLSTNE (Kmf)	20.5-21.5	California Sample							16/27
		23.0-24.0	California Sample							21/44
	35.0-37.5: SHALE (Kmf)	25.5-26.5	California Sample							25/50
		28.0-29.0	California Sample							42/50
	37.5-41.7: COAL (Kmf)	30.5-31.5	California Sample							39/50
		33.0-34.0	California Sample							Refusal
	41.7-50.5: SHALE (Kmf)	35.5-36.5	California Sample							47/50
		38.0-39.0	California Sample							41/50
		40.5-41.5	California Sample							Refusal
		43.0-44.0	California Sample							Refusal
		45.0-46.0	California Sample							Refusal
		48.0-49.0	No Recovery							Refusal

DRILL HOLES										
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA								BLOWS/0.5 (feet)
		DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE	
DHSTR7-16-7 Site Investigation	0.0-10.0: (SP-SM)gc (Qpd)	13.0-14.5	SM	47	53	0	NA	NP	2.7	10/17/20
		15.5-17.0	s(CL-ML)	66	33	1	22	6	3.4	20/32/29
	10.0-15.0: (SP-SM) (Qpd)	18.0-19.5	(ML)s	72	28	0	20	2	3.6	15/29/34
	15.0-20.1: SC (Qpd)	20.5-21.5	California Sample							22/50
		23.0-24.0	California Sample							17/25
	20.1-35.0: CLSTNE (Kmf)	28.0-29.0	California Sample							17/48
		33.0-34.0	California Sample							44/50
	35.0-45.0: SHALE (Kmf)	38.0-39.0	California Sample							32/50
		43.0-44.0	California Sample							Refusal
DHSTR7-16-8 Site Investigation	0.0-14.8: Cobbles & Boulders (Qpd)									
	14.8-20.2: (SM)g (Qpd)	20.0-21.5	s(CL)	56	40	4	31	20	9	8/17/15
	20.2-21.5: CLSTNE (Kmf)									
DHSTR7-16-9 Tank Site	0.0-19.8: Cobbles & Boulders (Qpd)	14.0-15.5	SM	14	74	12	NA	NP	2.0	18/31/30
	19.8-20.5: (SP-SM)g (Qpd)	19.0-20.5	(GM)s	20	35	45	NA	NP	2.4	10/16/20
DHSTR7-16-10 Tank Site	0.0-17.5: Cobbles & Boulders (Qpd)	19.0-20.5	SM	26	73	1	NA	NP	3.7	13/17/19
	17.5-24.1: (SP-SM)g (Qpd)									
	24.1-25.5: CLSTNE (Kmf)	24.0-25.5	CH	96	4	0	66	44	17.6	8/16/21
DHSTR7-16-11 Site Investigation	0.0-13.1: Cobbles & Boulders (Qpd)									
	13.1-16.8: (SM)g (Qpd)	19.0-20.0	California Sample							14/22
	16.8-20.0: CLSTNE (Kmf)									

DRILL HOLES										
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA								BLOWS/0.5 (feet)
		DEPTH (feet)	UNIFID SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE	
DHSTR7-16-12 Site Investigation	0.0-12.8: Cobbles & Boulders (Qpd)	15.0-16.5	CL	96	4	0	41	26	8.7	11/31/50
	12.8-15.3: (SM)g (Qpd)	19.0-20.0	California Sample							23/29
	15.3-31.8: CLSTNE (Kmf)	24.0-25.5	CH	99	1	0	73	50	4.1	9/16/31
	31.8-35.0: SS (Kmf)	29.0-30.0	California Sample							31/50
DHSTR7-16-13 Surge Tank	0.0-12.0: Cobbles & Boulders (Qpd)	15.4-16.5	CL	93	7	0	44	27	10.3	18/27/31
	12.0-15.4: SP-SM (Qpd)	20.0-21.0	California Sample							15/30
	15.4-33.2: CLSTNE (Kmf)	25.0-26.5	CH	99	1	0	69	50	18.4	13/19/25
	33.2-35.0: SHALE (Kmf)	30.0-31.0	California Sample							44/50
			33.5-35.0	CH	99	1	0	57	38	13.1
DHSTR7-16-14 Pumping Plant	0.0-17.5: Cobbles & Boulders (Qpd)	19.0-20.5	(SM)g	14	55	21	NA	NP	2.8	21/16/15
	17.5-33.6: (SP-SM)g (Qpd)	24.0-25.0	Sample not Preserved							22/30
	33.6-35.0: CLSTNE (Kmf)	29.0-30.5	No Recovery							24/48/42
			34.0-35.0	California Sample						
DHSTR7-16-15 Pumping Plant	0.0-16.8: Cobbles & Boulders (Qpd)	No Sampling Performed								NA
	16.8-31.5: (SM)g (Qpd)									
	31.5-34.0: CLSTNE (Kmf)									
DHSTR7-16-16 Pumping Plant	0.0-14.0: Cobbles & Boulders (Qpd)	No Sampling Performed								NA
	14.0-26.3: (SP-SM)g (Qpd)									
	26.3-29.0: CLSTNE (Kmf)									

DRILL HOLES											
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA								BLOWS/0.5 (feet)	
		DEPTH (feet)	UNIFID SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE		
DHSTR7-16-17 Pumping Plant	0.0-11.5: Cobbles & Boulders (Qpd)	<i>No Sampling Performed</i>								NA	
	11.5-23.8: (SP-SM) (Qpd)										
	23.8-27.0: (SP-SM)g (Qpd)										
	27.0-29.0: CLSTNE (Kmf)										
DHSTR7-16-18 Pumping Plant	0.0-16.0: Cobbles & Boulders (Qpd)	<i>No Sampling Performed</i>								NA	
	16.0-23.8: SM (Qpd)										
	23.8-29.0: CLSTNE (Kmf)										
DHPP4-16-6 Pipe Investigation	0.0-3.0: SC (Qal)	4.0-5.5	CL	90	10	0	36	17	8.3	22/46/50	
		6.5-7.5	<i>California Sample</i>								39/50
	3.0-9.5: SHALE (Kmf)	9.0-10.0	<i>California Sample</i>								21/35
	9.5-19.2: CLSTNE (Kmf)	14.0-15.0	<i>California Sample</i>								27/50
		19.0-20.0	<i>California Sample</i>								Refusal
	19.2-30.0: SS (Kmf)	21.0-22.0	<i>No Recovery</i>								Refusal
		24.0-25.0	<i>No Recovery</i>								Refusal

TABLE 2: SUMMARY OF TEST PIT INVESTIGATIONS

TEST PITS											
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA							COMPACTION TEST		
		DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE	IN-PLACE DRY DENSITY	D-VALUE AND MAXIMUM DRY DENSITY
TPSTR7-16-1 Tank	0.0-9.0: Cobbles & Boulders (Qpd)	-	-	-	-	-	-	-	-	-	-
TPSTR7-16-2 Tank	0.0-2.7: SM (Qpd) 2.7-10.5: Cobbles & Boulders (Qpd)	1.8-2.5	(SM)g	23	61	16	NA	NP	2.9	95.4 lb/ft <sup>3</sup>	D = 78.3 % 121.9 lb/ft <sup>3</sup> Opt = 11.0 %
TPSTR7-16-3 Chlorine Building	0.0-2.1: (SM)gc (Qpd) 2.1-11.1: Cobbles & Boulders (Qpd)	-	-	-	-	-	-	-	-	-	-
TPSTR7-16-4 Pumping Plant	0.0-11.5: Cobbles & Boulders (Qpd)	-	-	-	-	-	-	-	-	-	-
TPSTR7-16-5 Surge Tank	0.0-9.5: Cobbles & Boulders (Qpd)	-	-	-	-	-	-	-	-	-	-
TPSTR7-16-6 Access Road	0.0-12.0: Cobbles & Boulders (Qpd)	-	-	-	-	-	-	-	-	-	-

### **3.0 REGIONAL GEOLOGY**

The San Juan Basin is a broad basin that is surrounded by many mountain ranges with distinct geologies including the Chuska Mountains, the La Plata Mtns, the San Juan Mtns, the San Pedro Mtns, the Zuni Mtns. and Mt. Taylor. Characterized by plateaus, mesas and dry-wash canyons presently being eroded in an arid climate, the San Juan Basin is a structural depression that contains Quaternary and Tertiary alluvium, resting on rocks of Tertiary and Cretaceous age which crop out around the margins of the basin. The NGWSP San Juan Lateral is located on the east slope of the Chuska Mountains, near the southwestern margin of the basin north of Gallup, New Mexico. The eastern slope of the Chuska Mountains varies from landslides and pediments to many types of alluvium and mudflats. Bedrock units which outcrop along this portion of the San Juan Lateral are the Cretaceous Menefee Formation. The bedrock is typically covered on the surface by varying amounts of surficial deposits mapped on the surface as Quaternary Alluvium. The Menefee Formation sandstone generally forms cap rock on the hill tops and the softer claystone and shale units form the lower slopes on the hills.

### **4.0 SITE GEOLOGY**

Pumping Plant 4 is located on a pediment that is a remnant of erosional processes of the Chuska Mountains. Pediments slope gently away from higher elevations and develop when sheet flow erosion occurs during rain fall events. The pediment is flat on top and is flanked by steep, erosional escarpments that facilitate slope wash and alluvial deposition. The pediment is surrounded by low-lying alluvial valley and mud flats. The pediment is resistant to scour and sheet wash by a veneer of gravel, cobbles and boulders referred to as Quaternary Pediment Deposits (Qpd). Rounded to angular gravels, cobbles and boulders with clay and silt are encountered at the pumping plant foundation. Underlying the pediment deposit is the Cretaceous Menefee Formation that consists primarily of claystone, shale and coal.

#### **4.1 STRATIGRAPHY**

The geologic units encountered at the Pumping Plant 4 footprint consists of pediment deposits on claystone bedrock. The pediment deposits vary in depth but is generally found within 20 feet of the ground surface. Claystone is the predominant bedrock unit with inter-bedded shale and coal.

Sandstone units of the Menefee Formation outcrop on the pediment escarpment and were encountered in subsurface investigation in drill hole DHSTR7-16-12 at 31.8 feet and in drill hole DHPP4-16-6 at 24.5 feet below ground surface.

#### **4.1.1 SURFICIAL DEPOSITS**

##### **Quaternary Alluvium (Qal)**

Quaternary Alluvium are soils that overlie bedrock in the valleys surrounding the investigation site of Pumping Plant 4. Alluvium sampled in the valley is visually classified as Clayey Sand (SC). Soils are generally fine grain sands with variable amounts of plastic to nonplastic fines and occasionally contain gravel or cobbles. For more detail, see DHPP4-16-6 geologic log. The alluvium is derived from a variety of sources including slope wash, eolian and alluvial deposition as well as weathering and decomposition of in-place claystone bedrock. Quaternary Alluvium is used to describe these surficial deposits regardless of origin.

##### **Quaternary Pediment Deposits (Qpd)**

Pediment deposits are found on top of the sloped, erosional surface of the Cretaceous Menefee Formation within the project area. The pediment deposit is a veneer of alluvial material and consist of various amounts of clay and silt, sand, angular to rounded gravel and cobbles and often contain angular to rounded boulders. The material is generally described as Cobbles and Boulders with soils depending on composition. Lenses of fine grain soils range from Silty Sand (SM) to Silty Sand with Gravel (SM)g, Lean Clay (CL) and Sandy Lean Clay s(CL), Silt with Sand (ML)s and Sandy Silty Clay s(CL-ML), Silty Gravel with Sand (GM)s, Clayey Sand (SC) to Poorly Graded Sand with Silt (SP-SM) that may contain gravel. Material with oversize particles (greater than 3 inches) can be described using the USCS and are classified as Silty Sand with Gravel, Cobbles and Boulders (SM)gcb, Clayey Sand With Gravel, Cobbles and Boulders (SC)gcb, Poorly Graded Sand with Silt, Gravel, Cobbles and Boulders (SP-SM)gcb and Poorly Graded Gravel with Sand, Cobbles and Boulders (GP)scb. Material having a majority of oversize particles are referred to as Cobbles and Boulders. The gravel, cobbles and boulders are composed of hard sandstone with a trace of hard, basalt, quartzite, chert and petrified wood. These deposits originate primarily from the Chuska Mountains west of the project area.

#### **4.1.2 BEDROCK**

##### **Cretaceous Menefee Formation (Kmf)**

The Cretaceous Menefee Formation at Pumping Plant 4 consists primarily of light to dark gray claystone with interbedded coal and shale intervals. Claystone is generally soft (H6) and moderately weathered (W5) but can be very soft (H7) and very intensely weathered (W8) to decomposed (W9). Claystone has carbonaceous laminations, can be thinly bedded and grades to shale and coal. The claystone can be classified as Lean Clay (CL) and as Fat Clay (CH) when it is processed through laboratory methods. The shale is brown to black and is generally moderately soft (H5) and slightly to moderately weathered (W4) but can be soft (H6). Shale is thinly bedded with coal laminations, grades to coal and is fissile and friable. The coal units encountered are dark brown to black, soft (H6) and moderately to slightly weathered (W4). Coal can be laminated to thinly bedded, is brittle and has a dull luster. Sandstone units are fine grained, brownish orange to gray in color and vary from hard (H3) to soft (H6). Weathering of the sandstone range from moderately weathered (W5) to slightly weathered (W3). Gypsum and iron oxide staining is present in most bedrock units sampled. The bedrock locally has a shallow dip toward the northeast.

### **5.0 GEOLOGIC CONSIDERATIONS**

Concerns about the safety surrounding the geologic environment range from the stability of slopes in excavations, excavation methods, overhead utilities and scour potential. Specific situations are addressed below.

#### **5.1 STABILITY OF EARTH MATERIALS**

This section includes information on natural slope stability and recommends temporary and permanent cut slopes for both surficial deposits and bedrock. The stability of cut slopes is dependent upon the composition of materials and moisture conditions.

### **5.1.1 NATURAL SLOPE STABILITY**

The stability of surficial deposits in the foundation area is dependent primarily on material composition. Natural slopes in unconsolidated alluvium are generally stable at approximately 1.5:1 or flatter in sandy materials. Bedrock exposures in the area are typically stable at about 1.5:1 or steeper in claystone and shale, and 1:1 to vertical in sandstone.

### **5.1.2 TEMPORARY AND PERMANENT CUT SLOPES**

Recommendations for cut slopes in surficial deposits are based on material type and texture. All cut slopes shall be constructed in accordance with the Reclamation Safety and Health Standards and OSHA standards. Recommendations are for dry or adequately dewatered materials.

Materials with excessive moisture will require further flattening for stability. Recommended cut slopes for type C soils, including Poorly Graded Sand (SP), Poorly Graded Sand with Silt (SP-SM), Silty Sand (SM), and granular soils with gravel, cobbles and boulders are 1.5:1.

Recommended cut slopes for type B soils, including Silty Clayey Sand (SC-SM) and Clayey Sand (SC) are 1:1 or flatter.

Cut slopes in bedrock will be dependent upon the rock type and degree of weathering. All decomposed to intensely weathered, very soft to soft bedrock will be classified as a type B or type C soils depending upon the composition of the rock. Moderately weathered to fresh, moderately soft to hard bedrock can be classified as Stable Rock if all requirements of the Reclamation Safety and Health Standards are met. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

## **5.2 EXCAVATION CONSIDERATIONS**

Excavation in the pumping plant foundation will be primarily in pediment deposits. Pediment deposits contain oversize material greater than 3 inches that will need to be repurposed and may not be suitable as engineered backfill. Oversize material may be considered for use as slope protection or rip-rap as the pipe ascends or descends the flanking escarpments of the pediment. As a result of this excavated material being repurposed, there may be a need import material for compacted backfill from other sources. Test pits were excavated using common methods.

Unconsolidated soils and intensely weathered to decomposed bedrock can be excavated using common methods. Rock weathering transitions from decomposed (W9), and becomes less weathered with depth in claystone. Claystone units of the Menefee Formation are often weathered and soft and will likely be excavated by ripper-equipped dozers or large excavators with adequate pullout force and appropriate teeth. Industrial equipment should be expected to accomplish foundation excavation. Quaternary Pediment Deposits are expected to be encountered on top of the claystone.

#### **5.2.1 UTILITIES**

There is an overhead powerline that crosses the tank sites. This utility will be moved before construction begins and should not become an issue with the construction of Pumping Plant 4.

#### **5.3 SCOUR POTENTIAL**

Scour potential should not be an issue when excavations are properly sloped and storm water run-off is addressed.

## **6.0 REFERENCES**

USBR 5005 [Earth Manual, Part 2, Third Edition, and the Unified Soil Classification System (USCS)].

USBR, Engineering Geology Field Manual, Second Edition, volume 1.

# **APPENDIX 1**

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GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-1											SHEET 1 OF 1						
FEATURE: Pumping Plant 4 LOCATION: Site investigation BEGIN: 3/25/16 FINISHED: 3/25/16 DEPTH AND ELEVATION OF WATER LEVEL: NE DATE MEASURED: 3/25/2016			PROJECT: Navajo Gallup Water Supply Project COORDINATES: N 1,884,908.3 E 2,464,309.9 N.M. State Plane TOTAL DEPTH: 45.0 DEPTH TO BEDROCK: 26.2				STATE: New Mexico GROUND ELEVATION: 5866.7 ft. NAD 83 ANGLE FROM HORIZONTAL: 90 HOLE LOGGED BY: C. Boyer REVIEWED BY: J. Gilbert										
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 8.0 FT. 4 1/4" SSA WITH PILOT BIT. 8.0 TO 10.3 FT (REFUSAL). 4 1/4" HSA AND DRY CORE SYSTEM. 10.3 TO 13.0 FT. 4 1/4" SSA WITH PILOT BIT. 13.0 TO 18.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM. 18.0 TO 19.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER (ASSUMED CLAYSTONE). 19.0 TO 24.5 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS. 24.5 TO 45.0 FT. HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT. NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE. PEDIMENT GRAVEL DEPOSIT: NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE AND CUTTINGS.</p> <p>SAMPLING 18.0 TO 19.0 FT: CALIFORNIA SAMPLE (DISCARDED) 20.5 TO 22.0 FT: SPT 23.0 TO 24.5 FT: SPT 28.0 TO 29.0 FT: CALIFORNIA SAMPLE 30.5 TO 31.5 FT: CALIFORNIA SAMPLE 33.0 TO 34.0 FT: CALIFORNIA SAMPLE 35.5 TO 36.5 FT: CALIFORNIA SAMPLE 38.0 TO 39.0 FT: CALIFORNIA SAMPLE 40.5 TO 41.5 FT: CALIFORNIA SAMPLE 43.0 TO 44.0 FT: CALIFORNIA SAMPLE</p>	5		PILOT												0.0 TO 26.2 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)		
	10			39											SP-SM/sg	0.0 TO 17.9 FT POORLY GRADED SAND WITH SILT, GRAVEL AND COBBLES (SP-SM)gc. ABOUT 50% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 30% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY, AND NO DRY STRENGTH; GRAY IN COLOR; DRY; STRONG REACTION WITH HCl.	
	15			74												TOTAL SAMPLE (BY VOLUME) ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; REMAINDER MINUS 3-INCH, MAXIMUM SIZE, 200mm.	
	20			68												17.9 TO 22.7 FT POORLY GRADED SAND WITH SILT (SP-SM) ABOUT 90% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL, MAXIMUM SIZE, 20mm; DRY, BROWN IN COLOR; STRONG REACTION WITH HCl.	
	25			96										16/20		22.7 TO 26.2 FT SILTY SAND (SM); ABOUT 85% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND; ABOUT 15% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL, MAXIMUM SIZE, 25mm; DRY, GREY IN COLOR; NO REACTION WITH HCl.	
	30			88				40.1	59.9	0.0	NA	NP	2.8	SM	17/25/22	SP-SM	26.2 TO 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
	35			90												SM	26.2 TO 30.0 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W8), FROM 26.2 TO 28.7 FT. SOFT (H6) AND MODERATELY WEATHERED (W5) FROM 28.7 TO 30.0 FT. GREY IN COLOR, MOTTLED, LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.
	40					7	8									CLSTNE	30.0 TO 45.0 FT SHALE: SLIGHTLY FISSILE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT TO SOFT (H5-H6), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING. NO REACTION WITH HCl.
	45					6	5									9948.0	END OF HOLE, TOTAL DEPTH=45.0
																	STRATIGRAPHY: 0.0 - 26.2 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 26.2 - 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
																	9940.5
																	9944.0
																	9936.7
																	31/37
																	30/REFUSAL
																	46/REFUSAL
																	27/REFUSAL
																	REFUSAL
																	REFUSAL
																	REFUSAL
																9921.7	
BOTTOM OF HOLE																	

**COMMENTS:**

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWINGS NO. 40 D 6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40 D 6489, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE  
SPT= STANDARD PENETRATION TEST FeOx= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-2												SHEET 1 OF 1				
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Site Investigation			COORDINATES: N 1,884,661.2 E 2,464,323.5 N.M. State Plane				GROUND ELEVATION: 5865.5 ft. NAD-83									
BEGUN: 3/29/16 FINISHED: 3/29/16			TOTAL DEPTH: 45.0				ANGLE FROM HORIZONTAL: 90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 13.8				HOLE LOGGED BY: C. Boyer									
DATE MEASURED: 3/29/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 13.0 FT. 4 1/4" SSA WITH PILOT BIT 13.0 TO 14.5 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS. 14.5 TO 45.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT. NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT. NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. PILOT BIT HIT REFUSAL AT 3 FT ON FIRST ATTEMPT. MOVED RIG EAST ABOUT 1 FOOT. PILOT BIT REACHED REFUSAL AT 3 FT AGAIN. MOVED RIG EAST ABOUT 3 FEET AND RESUMED DRILLING.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLING: 13.0 TO 14.5 FT. SPT 18.0 TO 19.0 FT. CALIFORNIA SAMPLE 23.0 TO 24.0 FT. CALIFORNIA SAMPLE 28.0 TO 29.0 FT. CALIFORNIA SAMPLE 33.0 TO 34.0 FT. CALIFORNIA SAMPLE 38.0 TO 39.0 FT. CALIFORNIA SAMPLE 43.0 TO 44.0 FT. CALIFORNIA SAMPLE</p>	0														0.0 TO 13.8 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5															0.0 TO 11.0 FT POORLY GRADED SAND WITH SILT GRAVEL AND COBBLES (SP-SM)gc
	10															ABOUT 50% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 40% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH, GRAY IN COLOR, DRY, STRONG REACTION WITH HCl.
	15															TOTAL SAMPLE (BY VOLUME) ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; REMAINDER MINUS 3-INCH, MAXIMUM SIZE, 200mm.
	20															11.0 TO 13.8 FT POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)gc ABOUT 75% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 15% SUBANGULAR, HARD SANDSTONE GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH, MAXIMUM SIZE, 200mm, DRY, BROWN IN COLOR, STRONG REACTION WITH HCl.
	25															13.8 TO 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
	30															13.8 TO 35.2 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W8), FROM 13.8 TO 14.5 FT. SOFT (H6) AND MODERATELY WEATHERED (W5) FROM 14.5 TO 35.2 FT. GREY IN COLOR, MOTTLED, LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, IRON OXIDE STAINING, THIN CONCRETIONARY INTERBEDS FROM 15.5 TO 18.0 FT AND 18.0 TO 18.1 FT.
	35															35.2 TO 45.0 FT SHALE: SLIGHTLY FISSILE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT TO SOFT (H5-H6), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING, NO REACTION WITH HCl.
	40															END OF HOLE, TOTAL DEPTH= 45.0
	45															STRATIGRAPHY: 0.0 - 13.8 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 13.8 - 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)

**COMMENTS:**

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40 D 6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40 D 6489, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

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SPT= STANDARD PENETRATION TEST FeOx= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

SHEET 1 OF 1 DRILL HOLE: DHSTR7-16-2

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-3												SHEET 1 OF 1				
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Site Investigation			COORDINATES: N 1,884,889.2 E 2,464,201.7 N.M. State Plane				GROUND ELEVATION: 5867.9 ft. NAD-83									
BEGUN: 3/26/16 FINISHED: 3/26/16			TOTAL DEPTH: 45.0				ANGLE FROM HORIZONTAL: 90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 23.5				HOLE LOGGED BY: C. Boyer									
DATE MEASURED: 3/26/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 13.0 FT. 4 1/4" SSA WITH PILOT BIT 13.0 TO 22.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS 22.0 TO 45.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT. NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. PILOT BIT HIT REFUSAL AT 4 FT ON FIRST ATTEMPT. MOVED RIG EAST ABOUT 3 FEET. PILOT BIT REACHED REFUSAL AT 9 FT AGAIN. MOVED RIG EAST ABOUT 4 FEET AND RESUMED DRILLING.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLING: 18.0 TO 19.5 FT. SPT 20.5 TO 22.0 FT. SPT 25.5 TO 26.5 FT. CALIFORNIA SAMPLE 28.0 TO 29.0 FT. CALIFORNIA SAMPLE 30.5 TO 31.5 FT. CALIFORNIA SAMPLE 33.0 TO 34.0 FT. CALIFORNIA SAMPLE 35.5 TO 36.5 FT. CALIFORNIA SAMPLE 38.0 TO 39.0 FT. CALIFORNIA SAMPLE 40.5 TO 41.5 FT. CALIFORNIA SAMPLE 43.0 TO 44.0 FT. CALIFORNIA SAMPLE</p>	0.0														0.0 TO 23.5 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5		NR													0.0 TO 17.7 FT POORLY GRADED SAND WITH SILT GRAVEL AND COBBLES (SP-SM)gc; ABOUT 50% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 40% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; GRAY IN COLOR AND DRY; STRONG REACTION WITH HCl.
	10		Qpd													TOTAL SAMPLE (BY VOLUME); ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES, TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; REMAINDER MINUS 3-INCH, MAXIMUM SIZE, 200mm.
	15			32												17.7 TO 23.5 FT POORLY GRADED SAND WITH SILT (SP-SM); ABOUT 90% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL, MAXIMUM SIZE, 75mm; DRY, BROWN IN COLOR; STONG REACTION WITH HCl.
	20			96			36.6	54.6	6.8	NA	NP	3.2	SM	11/21/26		23.5 TO 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
	25			76			19.3	69.8	10.9	NA	NP	2.2	SM	14/27/30		23.5 TO 33.0 FT CLAYSTONE: VERY SOFT (H7) AND VERY INTENSELY WEATHERED (W8) FROM 23.5 TO 24.0 FT. SOFT (H6) AND MODERATELY WEATHERED (W5) FROM 24.0 TO 33.0 FT. GREY IN COLOR, MOTTLED, LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.
	30					7	8									33.0 TO 35.0 FT SHALE: SLIGHTLY FISSILE SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT TO SOFT (H5-H6), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING, NO REACTION WITH HCl.
	35															35.0 TO 35.9 FT COAL: LIGNITIC, BROWNISH BLACK IN COLOR, SOFT (H6), MODERATELY TO SLIGHTLY WEATHERED (W4), BRITTLE, DULL LUSTER, THINLY BEDDED TO LAMINATED.
	40					5										35.9 TO 45.0 FT SHALE: SLIGHTLY FISSILE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING, NO REACTION WITH HCl.
	45															END OF HOLE, TOTAL DEPTH= 45.0
																STRATIGRAPHY: 0.0 - 23.5 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 23.5 - 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
	BOTTOM OF HOLE															

**COMMENTS:**

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWINGS NO. 40 D 6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40 D 6489, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE  
SPT= STANDARD PENETRATION TEST FeOx= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID



GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-5												SHEET 1 OF 1					
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico										
LOCATION: Tank Site			COORDINATES: N 1,884,971.0 E 2,464,120.1 N.M. State Plane				GROUND ELEVATION: 5867.4 ft. NAD-83										
BEGIN: 3/27/16 FINISHED: 3/27/16			TOTAL DEPTH: 45.0				ANGLE FROM HORIZONTAL: 90										
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 18.0				HOLE LOGGED BY: P. Gardner, C. Boyer										
DATE MEASURED: 3/27/2016							REVIEWED BY: J. Gilbert										
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION		
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION	
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 13.0 FT. 4 1/4" SSA WITH PILOT BIT 13.0 TO 45.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT. NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT. NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. REACHED REFUSAL AT 4.0 FT ON FIRST ATTEMPT. MOVED 3.0 FT SOUTH AND RESUMED DRILLING.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLING: 20.5 TO 21.5 FT. CALIFORNIA SAMPLE 23.0 TO 24.0 FT. CALIFORNIA SAMPLE 25.5 TO 26.5 FT. CALIFORNIA SAMPLE 28.0 TO 29.0 FT. CALIFORNIA SAMPLE 30.5 TO 31.5 FT. CALIFORNIA SAMPLE 33.0 TO 34.0 FT. CALIFORNIA SAMPLE 35.5 TO 36.5 FT. CALIFORNIA SAMPLE 38.0 TO 39.0 FT. CALIFORNIA SAMPLE 40.5 TO 41.5 FT. CALIFORNIA SAMPLE 43.0 TO 44.0 FT. CALIFORNIA SAMPLE</p>															0.0 TO 18.0 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)		
		5														SM 5964.9	0.0 TO 2.5 FT SILTY SAND (SM); ABOUT 55% FINE SAND; ABOUT 45% FINES WITH NO PLASTICITY; NO DRY STRENGTH AND SLOW DILATANCY; TRACE GRAVEL. MAXIMUM SIZE, 30mm; BROWN IN COLOR. DRY. STRONG REACTION WITH HCl.
		10	Qpd													(SP)gc	2.5 TO 18.0 FT POORLY GRADED SAND WITH GRAVEL AND COBBLES (SP)gc; ABOUT 55% PREDOMINATELY FINE SAND; TRACE MEDIUM TO COARSE SAND; ABOUT 40% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL; ABOUT 5% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; LIGHT BROWN IN COLOR. STRONG REACTION WITH HCl.
		15		52													TOTAL SAMPLE (BY VOLUME); ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; REMAINDER MINUS 3-INCH; MAXIMUM SIZE, 200mm.
		20				7	8									5949.4	18.0 TO 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
		25															18.0 TO 32.5 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W8); FROM 18.0 TO 18.5 FT. SOFT (H8) AND MODERATELY WEATHERED (W9) FROM 18.5 TO 32.5 FT. GREY IN COLOR, MOTTLED, LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING. BECOMES MORE CARBONACEOUS WITH INCREASED COAL LAMINATIONS FROM 29.0 TO 34.0 FT.
		30															32.5 TO 45.0 FT SHALE: SLIGHTLY FISSILE, FRIABLE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VEINS, AND IRON OXIDE STAINING. NO REACTION WITH HCl.
		35															END OF HOLE, TOTAL DEPTH= 45.0
		40															STRATIGRAPHY: 0.0 - 18.0 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 18.0 - 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
		45															

**COMMENTS:**

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SPT= STANDARD PENETRATION TEST FeOx= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

SHEET 1 OF 1 | DRILL HOLE: DHSTR7-16-5

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-6											SHEET 1 OF 1					
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Site investigation			COORDINATES: N 1,884,790.2 E 2,464,015.5 N.M. State Plane				GROUND ELEVATION: 5871.1 ft. NAD-83									
BEGUN: 3/23/16 FINISHED: 3/23/16			TOTAL DEPTH: 50.5				ANGLE FROM HORIZONTAL: 90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 12.6				HOLE LOGGED BY: C. Boyer									
DATE MEASURED: 3/23/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILLEBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 7.0 FT: 4 1/4" SSA WITH PILOT BIT. 7.0 TO 13.0 FT: 4 1/4" HSA AND DRY CORE SYSTEM. 13.0 TO 50.5 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 50.5 FT: NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT DEPOSIT; NO SPTS WERE CONDUCTED. VERY DIFFICULT AUGERING THROUGH PEDIMENT DEPOSIT. 50 POUND BAG SAMPLE COLLECTED FROM 0.0 TO 7.0 FT. THE CALIFORNIA SAMPLE TUBE PROVIDED WAS NOT A SPLIT SPOON SAMPLER. BRASS TUBES WERE REMOVED WITH A WOODEN DOWEL AND HAMMER. SAMPLE QUALITY MAY HAVE BEEN COMPROMISED. IN ADDITION, PLASTIC WRAP AND DUCT TAPE USED TO PRESERVE MOISTURE OF SOME SAMPLES. A SPLIT SAMPLE TUBE AND PLASTIC CAPS WERE MAILED OVERNIGHT.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLING: 13.0 TO 14.0 FT: CALIFORNIA SAMPLE 15.5 TO 16.5 FT: CALIFORNIA SAMPLE 18.0 TO 19.0 FT: CALIFORNIA SAMPLE 20.5 TO 21.5 FT: CALIFORNIA SAMPLE 23.0 TO 24.0 FT: CALIFORNIA SAMPLE 25.5 TO 26.5 FT: CALIFORNIA SAMPLE 28.0 TO 29.0 FT: CALIFORNIA SAMPLE 30.5 TO 31.5 FT: CALIFORNIA SAMPLE 33.0 TO 34.0 FT: CALIFORNIA SAMPLE 35.5 TO 36.5 FT: CALIFORNIA SAMPLE 38.0 TO 39.0 FT: CALIFORNIA SAMPLE 40.5 TO 41.5 FT: CALIFORNIA SAMPLE 43.0 TO 44.0 FT: CALIFORNIA SAMPLE 45.0 TO 46.0 FT: CALIFORNIA SAMPLE 48.0 TO 49.0 FT: CALIFORNIA SAMPLE (NO RECOVERY)</p>	0.0													0.0 TO 12.6 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)		
	0.0 TO 12.6 FT POORLY GRADED GRAVEL WITH SAND AND COBBLES (GP)sc ABOUT 80% PREDOMINATELY FINE SUBANGULAR HARD SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL. TRACE COARSE GRAVEL. ABOUT 30% PREDOMINATELY FINE SAND. TRACE MEDIUM TO COARSE SAND. ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH.															
	5		PILOT												0.0 TO 12.6 FT POORLY GRADED GRAVEL WITH SAND AND COBBLES (GP)sc ABOUT 80% PREDOMINATELY FINE SUBANGULAR HARD SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL. TRACE COARSE GRAVEL. ABOUT 30% PREDOMINATELY FINE SAND. TRACE MEDIUM TO COARSE SAND. ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH.	
	7					7	8								TOTAL SAMPLE (BY VOLUME): ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES, REMAINDER MINUS 3-INCH, MAXIMUM SIZE, 125mm.	
	10														12.6 TO 50.5 FT CRETACEOUS MENEFFEE FORMATION (Kmf)	
	13		PILOT												12.6 TO 35.0 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W8), FROM 12.6 TO 13.2 FT. SOFT (H8) AND MODERATELY WEATHERED (W5) FROM 13.2 TO 35.0 FT. GREY IN COLOR, MOTTLED, THINLY BEDDED TO LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.	
	15														35.0 TO 37.5 FT SHALE: SLIGHTLY FISSILE, FRIABLE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VENS, AND IRON OXIDE STAINING. NO REACTION WITH HCl.	
	18														37.5 TO 41.7 FT COAL: LIGNITIC, BROWNISH BLACK IN COLOR, SOFT (H8), MODERATELY TO SLIGHTLY WEATHERED (W4), BRITTLE, DULL LUSTER, THINLY BEDDED TO LAMINATED, NO REACTION WITH HCl.	
	20														41.7 TO 50.5 FT SHALE: SLIGHTLY FISSILE, FRIABLE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VENS, AND IRON OXIDE STAINING. NO REACTION WITH HCl.	
	25					6	5								JOINT MEASUREMENTS: DEPTH INCL R M T HL INFILLING 41.7-48.8 90 5 2 3 5 IRON OXIDE	
	28														END OF HOLE, TOTAL DEPTH= 50.5	
	30														STRATIGRAPHY: 0.0 - 12.6 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 12.6 - 50.5 FT CRETACEOUS MENEFFEE FORMATION (Kmf)	
	35															
	40															
	45															
	50															
	BOTTOM OF HOLE															

**COMMENTS:**

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40 D 8483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40 D 6489, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE  
SPT= STANDARD PENETRATION TEST FeOx= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-7												SHEET 1 OF 1				
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Site Investigation			COORDINATES: N 1,884,852.7 E 2,464,095.3 N.M. State Plane				GROUND ELEVATION: 5869.1 RL NAD-83									
BEGUN: 3/28/16 FINISHED: 3/28/16			TOTAL DEPTH: 45.0				ANGLE FROM HORIZONTAL: 90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 20.1				HOLE LOGGED BY: C. Boyer									
DATE MEASURED: 3/28/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILLEBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 13.0 FT. 4 1/4" SSA WITH PILOT BIT. 13.0 TO 20.5 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS. 20.5 TO 45.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT. NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT. NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. REACHED REFUSAL AT 2.0 FT ON FIRST ATTEMPT. MOVED ABOUT 4 FEET NORTHEAST AND RESUMED DRILLING.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLES: 13.0 TO 14.5 FT: SPT 15.5 TO 17.0 FT: SPT 18.0 TO 19.5 FT: SPT 20.5 TO 21.5 FT: CALIFORNIA SAMPLE 23.0 TO 24.0 FT: CALIFORNIA SAMPLE 26.0 TO 29.0 FT: CALIFORNIA SAMPLE 33.0 TO 34.0 FT: CALIFORNIA SAMPLE 38.0 TO 39.0 FT: CALIFORNIA SAMPLE 43.0 TO 44.0 FT: CALIFORNIA SAMPLE</p>	0.0														0.0 TO 20.1 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5		PILOT													0.0 TO 10.0 FT POORLY GRADED SAND WITH SILT AND GRAVEL, COBBLES AND BOULDERS (SP-SM)gcb; ABOUT 50% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND; ABOUT 40% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL; ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; DRY, GRAY IN COLOR, STRONG REACTION WITH HCl.
	10		Qpd													TOTAL SAMPLE (BY VOLUME); ABOUT 5% TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; ABOUT 5% TO 12 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; TRACE HARD, SUBANGULAR SANDSTONE BOULDERS; REMAINDER MINUS 3-INCH; MAXIMUM SIZE, 450mm.
	15			100				46.6	53.4	0.0	NA	NP	2.7	SM	10/17/20	10.0 TO 15.0 FT POORLY GRADED SAND WITH SILT (SP-SM); ABOUT 90% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND; ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL, MAXIMUM SIZE, 20mm; DRY, BROWN IN COLOR, STONG REACTION WITH HCl.
	20			100				86.2	33.1	0.7	22.0	6.1	3.4	CL-ML	20/32/29	15.0 TO 20.1 FT CLAYEY SAND (SC); ABOUT 80% PREDOMINATELY FINE SAND; ABOUT 20% FINES WITH LOW PLASTICITY; LOW DRY STRENGTH AND LOW TOUGHNESS; TRACE MEDIUM TO COARSE SAND; GRAY IN COLOR; DRY, STRONG REACTION WITH HCl.
	25			100		7	8									20.1 TO 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
	30			100												20.1 TO 35.0 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W8), FROM 20.1 TO 20.6 FT. SOFT (H6) AND MODERATELY WEATHERED (W5) FROM 20.6 TO 35.0 FT. GREY IN COLOR, MOTTLED, THINLY BEDDED TO LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.
	35			100												35.0 TO 45.0 FT SHALE: SLIGHTLY FISSILE, FRIABLE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VEINS, AND IRON OXIDE STAINING. NO REACTION WITH HCl.
	40			100		5	4									END OF HOLE, TOTAL DEPTH=45.0
	45			100												STRATIGRAPHY: 0.0 - 20.1 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 20.1 - 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
																BOTTOM OF HOLE

**COMMENTS:**

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40 D 6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40 D 6489, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE  
SPT= STANDARD PENETRATION TEST FeOx= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-8													SHEET 1 OF 1		
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico								
LOCATION: Site Investigation			COORDINATES: N 1,885,079.2 E 2,464,339.0 N.M. State Plane				GROUND ELEVATION: 5862.6 ft. NAD-83								
BEGUN: 8/2/16 FINISHED: 8/2/16			TOTAL DEPTH: 21.5				ANGLE FROM HORIZONTAL: 90								
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 20.2				HOLE LOGGED BY: P. Gardner								
DATE MEASURED: 8/2/2016							REVIEWED BY: J. Gilbert								
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew <b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> CME Model 85 truck mounted rotary drill rig</p> <p><b>DRILL METHOD:</b> 0.0 to 20.0. 4.25 inch HSA with pilot bit 20.0 to 21.5. 4.25 inch HSA with SPT</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 21.5. None</p> <p><b>DRILLING NOTES:</b> 0.0 to 20.0. Difficult with pilot bit to 14.8. 20.0 to 21.5. SPT</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLES:</b> 20.0 to 21.5. SPT</p>	5														0.0 to 20.2 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)
	10	Qpd	NR												
	15														MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel; about 30% fine to medium, subrounded sand; about 20% nonplastic fines; no reaction with HCl.
	20														0.0 to 20.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravels. Strong reaction with HCl.
	20	Kmf	93	NA	6	8	55.8	40.4	3.8	31.0	20.3	9.0	s(CL)	8/17/15	20.0 to 20.2 ft SILTY SAND WITH GRAVEL (SM): About 70% fine to coarse, hard sand; about 15% fine, hard, subangular to angular gravels; about 15% nonplastic fines; light brown and clay; strong reaction with HCl.
															20.2 to 21.5 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
															20.2 to 21.5 ft CLAYSTONE: Brownish gray and orange in color. Soft (H6) and vary intensely weathered (WB). FeOx staining present.
															STRATIGRAPHY: 0.0 to 20.2 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 20.2 to 21.5 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
															5842.4
															5841.1
BOTTOM OF HOLE															
<p><b>COMMENTS:</b></p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>															
													SHEET 1 OF 1		DRILL HOLE DHSTR7-16-8

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-9												SHEET 1 OF 1				
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Tank Site			COORDINATES: N 1,885,016.6 E 2,464,274.7 N.M. State Plane				GROUND ELEVATION: 5885.0 ft. NAD-83									
BEGIN: 7/28/16 FINISHED: 7/28/16			TOTAL DEPTH: 20.5				ANGLE FROM HORIZONTAL: -90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: NE				HOLE LOGGED BY: P. Gardner, C. Boyer									
DATE MEASURED: 7/28/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew <b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> CME Model 85 truck mounted rotary drill rig</p> <p><b>DRILL METHOD:</b> 0.0 to 9.0: 4.25 inch HSA with pilot bit. 9.0 to 20.5: 4.25 inch HSA dry core system with SPT.</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 20.5: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 9.0: Difficult with pilot bit 9.0 to 20.5: Easy drilling</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLING:</b> 14.0 to 15.5: SPT 19.0 to 20.5: SPT</p>	5		NR												0.0 to 20.5 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)	
																0.0 to 9.0: COBBLES AND BOULDERS WITH SILTY SAND AND GRAVEL: Visual classification from test pit 50 feet to the south of drill hole with about 60% 3 to 5 inch hard, subrounded to subangular cobbles; about 10% 5 to 12 inch hard, subangular to subrounded cobbles; about 10% hard, subrounded boulders; remainder minus 3 inch; maximum size, 700mm. Bottom of interval determined by drill action.
																MINUS 3 inch FRACTION (BY MASS): About 50% fine to medium, subrounded sand; about 30% hard, subrounded gravel; about 20% nonplastic fines; dry and tan in color; no reaction with HCl.
																0.0 to 9.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
																9.0 to 14.0 ft Poor Recovery: Materials recovered were approx. 80% fine to coarse, hard sand; approx. 10% fine to coarse, hard, subangular to angular gravel; approx. 10% nonplastic fines; light brown and dry; strong reaction with HCl.
	10		Qpd												14.0 to 15.5 ft SILTY SAND (SM): About 75% fine to coarse, hard sand; about 15% nonplastic fines; about 10% fine to coarse, hard, subangular to angular gravel; light brown and dry; strong reaction with HCl.	
															15.5 to 19.0 ft Poor Recovery: Materials recovered were approx. 80% fine to coarse, hard sand; approx. 10% fine to coarse, hard, subangular to angular gravel; approx. 10% nonplastic fines; light brown and dry; strong reaction with HCl.	
															19.0 to 20.5 ft POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM): About 60% fine to coarse, hard sand; about 30% fine, hard gravel; about 10% fines with no plasticity; maximum size, 10mm; light brown and dry; strong reaction with HCl.	
	15		83				14.2	73.7	12.1	NA	NP	2.0	SM	18/31/30	SM	STRATIGRAPHY: 0.0 to 20.5 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)
																5851.0
																5848.5
			NR													
																5946.0
	20		93				19.8	35.0	45.2	NA	NP	2.4	GM/s	10/16/20	(SP-SM)g	5944.5
																5944.5
BOTTOM OF HOLE																
<b>COMMENTS:</b>																
<p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																
												SHEET 1 OF 1	DRILL HOLE: DHSTR7-16-9			









GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-14												SHEET 1 OF 1			
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico								
LOCATION: Pumping Plant			COORDINATES: N 1,884,790.3 E 2,464,246.4 N.M. State Plane				GROUND ELEVATION: 5867.8 ft. NAD-83								
BEGIN: 7/29/16 FINISHED: 7/29/16			TOTAL DEPTH: 35.0				ANGLE FROM HORIZONTAL: 90								
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 33.6				HOLE LOGGED BY: P. Gardner								
DATE MEASURED: 7/29/2016							REVIEWED BY: J. Gilbert								
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew <b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Ruben Perez <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> CME Model 85 truck mounted rotary drill rig.</p> <p><b>DRILL METHOD:</b> 0.0 to 17.5: 4.25 inch HSA with pilot bit. 17.5 to 35.0: 4.25 inch HSA dry core system with SPT and California Sampler</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 35.0: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 17.5: Difficult to 12.0 and easy through 13.5. Difficult to 17.5 and lost pilot bit teeth. 17.5 to 35.0: HSA dry core, SPT and California sampling</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLING:</b> 19.0 to 20.5: SPT 24.0 to 25.0: California Sample (discarded) 29.0 to 30.5: SPT (no recovery) 34.0 to 35.0: California Sample</p>	5														0.0 to 33.6 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)
	10		NR												0.0 to 17.5 ft COBBLES AND BOULDERS WITH SILTY GRAVEL AND SAND: Visual classification from test pit 50 feet to the south of drill hole with about 60% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders; remainder minus 3 inch; maximum size, 1000mm. Bottom of interval determined by drill action.
	15														MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel; about 30% fine to medium, subrounded sand; about 20% nonplastic fines; dry and tan in color; no reaction with HCl.
	20	Qpd		80			24.2	54.5	21.3	NA	NP	2.8	(SM)g	21/16/15	0.0 to 17.5 ft Pilot Bit: Large boulder at the surface. Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl
	25			20											17.5 to 20.5 ft POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)g: About 70% fine to coarse, hard sand; about 20% fine, hard, subangular to angular gravel; about 10% nonplastic fines; light brown and dry; strong reaction with HCl.
	30														20.5 to 33.6 ft Poor Recovery: Materials recovered were approx. 55% fine to coarse, hard, subangular to angular gravel; approx. 30% fine to coarse, hard sand; approx. 15% nonplastic fines; maximum size, 75mm; light brown and dry; strong reaction with HCl.
	35														33.6 to 35.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
															33.6 to 35.0 ft CLAYSTONE: Brownish gray and orange in color. Soft (HS) and very intensely weathered (WB). FeOx staining present.
															STRATIGRAPHY: 0.0 to 33.6 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 33.6 to 35.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
															CLSTNE

**COMMENTS:**  
HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate  
MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-15													SHEET 1 OF 1		
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico								
LOCATION: Pumping Plant			COORDINATES: N 1,884,855.2 E 2,464,265.8 N.M. State Plane				GROUND ELEVATION: 5867.3 ft. NAD-83								
BEGUN: 8/2/16 FINISHED: 8/3/16			TOTAL DEPTH: 34.0				ANGLE FROM HORIZONTAL: 90								
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 31.5				HOLE LOGGED BY: P. Gardner								
DATE MEASURED: 8/3/2016							REVIEWED BY: J. Gilbert								
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew <b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> CME Model 85 truck mounted rotary drill rig</p> <p><b>DRILL METHOD:</b> 0.0 to 20.0: 4.25 inch HSA with pilot bit 20.0 to 34.0: 4.25 inch HSA and dry core system.</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 34.0: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 20.0: Difficult with pilot bit. 20.0 to 34.0: Poor recovery.</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLES:</b> No sampling performed.</p>	5														0.0 to 31.5 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)
	10														0.0 to 16.8 ft COBBLES AND BOULDERS WITH SILTY GRAVEL AND SAND: Visual classification from test pit 150 feet to the south of drill hole with about 60% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders; remainder minus 3 inch; maximum size, 1000mm. Bottom of interval determined by drill action.
	15	Qpd													MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel; about 30% fine to medium, subrounded sand; about 20% nonplastic fines; no reaction with HCl.
	20			100											0.0 to 20.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
	25			53											20.0 to 24.0 ft SILTY SAND WITH GRAVEL (SM): About 65% fine to coarse, hard sand; about 15% fine, hard, subangular to angular gravel; about 20% nonplastic fines; light brown and dry; strong reaction with HCl.
	30			2											24.0 to 31.5 ft Poor Recovery: Materials recovered were approx. 65% fine to coarse, hard sand; approx. 25% fine to coarse, hard, subangular to angular gravel; approx. 10% nonplastic fines; maximum size, 75mm; light brown and dry; strong reaction with HCl.
	34			4		6	8								31.5 to 34.0 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
															31.5 to 34.0 ft CLAYSTONE: Brownish gray and tan to orange in color. Soft (H6) and very intensely weathered (W8). FeOx staining present.
															STRATIGRAPHY: 0.0 to 31.5 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 31.5 to 34.0 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
															5947.3
														(SM)g	
														5943.3	
														5935.8	
														CLSTNE	
														5933.3	
BOTTOM OF HOLE															
<p><b>COMMENTS:</b></p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>															

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-16													SHEET 1 OF 1		
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico								
LOCATION: Pumping Plant			COORDINATES: N 1,884,854.7 E 2,464,222.3 N.M. State Plane				GROUND ELEVATION: 5867.9 ft. NAD-83								
BEGUN: 8/1/16 FINISHED: 8/1/16			TOTAL DEPTH: 29.0				ANGLE FROM HORIZONTAL: 90								
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 28.3				HOLE LOGGED BY: P. Gardner								
DATE MEASURED: 8/1/2016							REVIEWED BY: J. Gilbert								
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew</p> <p><b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> CME Model 85 truck mounted rotary drill rig.</p> <p><b>DRILL METHOD:</b> 0.0 to 15.0: 4.25 inch HSA with pilot bit. 15.0 to 29.0: 4.25 inch HSA and dry core system.</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 29.0: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 14.0: Difficult with pilot bit 14.0 to 29.0: Gravels through 21.0 to 22.5 and at 25.0.</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLING:</b> No sampling performed.</p>	0.0													0.0 to 26.3 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5													0.0 to 14.0 ft COBBLES AND BOULDERS WITH SILTY GRAVEL AND SAND: Visual classification from test pit 150 feet to the south of drill hole with about 60% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders; remainder minus 3 inch; maximum size, 1000mm. Bottom of interval determined by drill action.	
	10													MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel; about 30% fine to medium, subrounded sand; about 20% nonplastic fines; no reaction with HCl.	
	15	Qpd												0.0 to 15.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.	
	20													15.0 to 19.0 ft No Recovery: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.	
	25													19.0 to 26.3 ft POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)g: About 70% fine to coarse, hard sand; about 20% fine, hard, subangular to angular gravel; about 10% nonplastic fines; light to dark brown, dry, FeOx staining present; strong reaction with HCl.	
															26.3 to 29.0 ft CRETACEOUS MENEFE FORMATION (Kmf)
															26.3 to 29.0 ft CLAYSTONE: Brownish gray and tan in color. Soft (H8) and very intensely weathered (W8). FeOx staining present.
															STRATIGRAPHY: 0.0 to 26.3 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 26.3 to 29.0 ft CRETACEOUS MENEFE FORMATION (Kmf)
															5853.9
														5848.9	
														(SP-SM)g	
														5841.6	
														CLSTNE	
														5838.9	
														BOTTOM OF HOLE	
<p><b>COMMENTS:</b></p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>															

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-17													SHEET 1 OF 1		
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico								
LOCATION: Pumping Plant			COORDINATES: N 1,884,725.7 E 2,464,263.0 N.M. State Plane				GROUND ELEVATION: 5867.2 ft. NAD-83								
BEGUN: 7/31/16 FINISHED: 7/31/16			TOTAL DEPTH: 29.0				ANGLE FROM HORIZONTAL: -90								
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 27.0				HOLE LOGGED BY: P. Gardner								
DATE MEASURED: 7/31/2016							REVIEWED BY: J. Gilbert								
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew <b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Ruben Perez <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> CME Model 85 truck mounted rotary drill rig.</p> <p><b>DRILL METHOD:</b> 0.0 to 15.0: 4.25 inch HSA with pilot bit. 0.0 to 29.0: 4.25 inch HSA and dry core system.</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 29.0: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 13.5: Difficult with pilot bit 13.5 to 29.0: Poor recovery</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLING:</b> No sampling performed.</p>	0.0													0.0 to 27.0 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5													Cobbles and Boulders	0.0 to 11.5 ft COBBLES AND BOULDERS WITH SILTY SAND: Visual classification from test pit 25 feet to the south of drill hole with about 60% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders, remainder minus 3 inch; maximum size, 900mm. Bottom of interval determined by drill action.
	10														MINUS 3 inch FRACTION (BY MASS): About 80% fine sand; about 20% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.
	15	Qpd													0.0 to 15.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
	20			10											15.0 to 23.8 ft Poor Recovery: Materials recovered were approx. 70% fine to coarse, hard sand; approx. 20% fine, hard, subangular to angular gravel; approx. 10% nonplastic fines, light brown and dry, strong reaction with HCl.
	25			4											23.8 to 27.0 ft Poor Recovery: Materials recovered were approx. 60% fines with low plasticity; approx. 30% fine to coarse, hard sand; approx. 10% fine to coarse, hard, subangular to angular gravel; dark brown to gray and dry; no reaction with HCl.
	27.0														27.0 to 29.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
	27.0														27.0 to 29.0 ft CLAYSTONE: Brownish gray and tan to orange in color. Soft (H6) and very intensely weathered (WB). FeOx staining present.
	29.0			22											STRATIGRAPHY: 0.0 to 27.0 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 27.0 to 29.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
						6	8								CLSTNE
BOTTOM OF HOLE															

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.





7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-1</b>		SHEET 1 OF 1	
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT			
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5866.7			
COORDINATES: N 1,884,951 E 2,464,253		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE			
APPROXIMATE DIMENSIONS: 5'X12'X9'		LOGGED BY: J. GILBERT			
DEPTH TO WATER: NE DATE: 8/1/2016		DATE EXCAVATED: 8/1/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	COBBLES AND BOULDERS	0.0 to 9.0 ft COBBLES AND BOULDERS WITH SILTY SAND WITH GRAVELS: TOTAL SAMPLE (BY VOLUME): About 60% 3- to 5-inch hard subrounded to subangular cobbles; about 10% 5- to 12-inch hard, subangular to subrounded cobbles; about 10% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 700 mm.  MINUS 3-inch FRACTION (BY MASS): About 50% fine to medium subrounded sand; about 30% hard subrounded gravel; about 20% nonplastic fines; no reaction with HCl.  IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.  GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)	60	10	10
2					
3					
4					
5					
6					
7					
8					
9					
<p>COMMENTS: Surface vegetation consists of grasses, weeds and brush. Discontinued hole due to limit of equipment. Corrosion sample taken at 8.5 feet.</p> <p>NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid</p>					

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-2</b>		SHEET 1 OF 1		
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT				
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5867.3				
COORDINATES: N 18,849,191 E 2,464,104		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE				
APPROXIMATE DIMENSIONS: 7'X12'X10.5'		LOGGED BY: J. GILBERT				
DEPTH TO WATER: NE DATE: 8/1/2016		DATE EXCAVATED: 8/1/2016				
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)			
			3 - 5 in	5 - 12 in	PLUS 12 in	
1	SM (visual) (SM)g (lab classification)	0.0 to 2.7 ft SILTY SAND: About 80% fine sand; about 20% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; weak reaction with HCl.				
2	In-place Density taken at 1.8 ft 2.7 ft (5864.6)	IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous.  IN-PLACE UNIT WEIGHT AND MOISTURE FROM 1.8 TO 2.5 ft. Total: 95.4 lbs. / cu ft., 2.9%. (78.3% compaction) LAB TEST DATA: 61.5% sand, 22.7% fines, 15.8% gravel, LL= NA, PI= NP, SPG= 2.57				
3	COBBLES AND BOULDERS	Maximum dry density= 121.9 lbs. / cu ft., optimum water content= 11.0% Laboratory classification is: SILTY SAND WITH GRAVEL	65	20	5	
4		GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd) 2.7 to 10.5 ft: COBBLES AND BOULDERS WITH SILTY SAND WITH GRAVEL : TOTAL SAMPLE (BY VOLUME): About 65% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 5% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 700 mm.				
5		MINUS 3-inch FRACTION (BY MASS): About 50% fine to medium subrounded sand; about 30% hard subrounded gravel; about 20% nonplastic fines; no reaction with HCl.				
6		IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.				
7		GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)				
8						
9						
10						
	10.5 ft (5856.8)					
COMMENTS: Discontinued hole due to limit of equipment. In-place density taken at 1.8 feet.						
NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid						

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-3</b>		SHEET 1 OF 1	
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT			
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5869.2			
COORDINATES: N 1,884,912 E 2,464,109		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE			
APPROXIMATE DIMENSIONS: 6'X11'X11.1'		LOGGED BY: J. GILBERT			
DEPTH TO WATER: NE DATE: 8/1/2016		DATE EXCAVATED: 8/1/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	(SM)gc	0.0 to 2.1 ft SILTY SAND WITH GRAVEL AND COBBLES: About 50% hard subrounded gravel; about 30% non plastic fines, rapid dilatancy and no dry strength; about 20% fine sand; trace of cobbles; maximum size, cobble; no reaction with HCl.	tr		
2	2.1 ft (5867.1)	IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous.			
3	COBBLES AND BOULDERS	GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd) 2.1 to 11.1 ft COBBLES AND BOULDERS WITH SILTY GRAVEL WITH SAND: TOTAL SAMPLE (BY VOLUME): About 65% 3- to 5-inch hard subrounded to subangular cobbles; about 15% 5- to 12-inch hard, subangular to subrounded cobbles; about 10% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 700 mm.	65	15	10
4		MINUS 3-inch FRACTION (BY MASS): About 50% hard subrounded gravel; about 30% fine to medium subrounded sand; about 20% nonplastic fines; no reaction with HCl.			
5		IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.			
6		GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd).			
7					
8					
9					
10					
11	11.1 ft (5858.1)				
COMMENTS: Discontinued hole due to limit of equipment and sloughing.					
NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid					

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-4</b>		SHEET 1 OF 1		
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT				
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5867.9				
COORDINATES: N 1,884,771 E 2,464,248		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE				
APPROXIMATE DIMENSIONS: 6'X11'X11.5'		LOGGED BY: J. GILBERT				
DEPTH TO WATER: NE DATE: 8/2/2016		DATE EXCAVATED: 8/2/2016				
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)			
			3 - 5 in	5 - 12 in	PLUS 12 in	
1	COBBLES AND BOULDERS	0.0 to 11.5 ft COBBLES AND BOULDERS WITH SILTY GRAVEL WITH SAND : TOTAL SAMPLE (BY VOLUME): About 60% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 15% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 1000 mm.  MINUS 3-inch FRACTION (BY MASS): About 50% hard subrounded gravel; about 30% fine to medium subrounded sand; about 20% nonplastic fines; no reaction with HCl.  IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.  GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)	60	20	15	
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
11.5 ft (5856.4)						
COMMENTS: Discontinued due to limit of equipment. Corrosion sample taken at 10.0 ft.  NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid						

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-5</b>		SHEET 1 OF 1	
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT			
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5867.2			
COORDINATES: N 1,884,698 E 2,464,276		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE			
APPROXIMATE DIMENSIONS: 7'X12'X9.5'		LOGGED BY: J. GILBERT			
DEPTH TO WATER: NE DATE: 8/3/2016		DATE EXCAVATED: 8/3/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1 2 3 4 5 6 7 8 9 9.5 ft (5857.7)	COBBLES AND BOULDERS	<p>0.0 to 9.5 ft COBBLES AND BOULDERS WITH SILTY SAND : TOTAL SAMPLE (BY VOLUME): About 60% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 15% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 900 mm.</p> <p>MINUS 3-inch FRACTION (BY MASS): About 80% fine sand; about 20% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.</p> <p>IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.</p> <p>GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)</p>	60	20	15
<p>COMMENTS: Discontinued due to limit of equipment and sloughing sidewalls.</p> <p>NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid</p>					

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-6</b>		SHEET 1 OF 1	
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT			
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5860.5			
COORDINATES: N 1,885,280 E 2,464,196		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE			
APPROXIMATE DIMENSIONS: 7'X12'X12'		LOGGED BY: J. GILBERT			
DEPTH TO WATER: NE DATE: 8/3/2016		DATE EXCAVATED: 8/3/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	COBBLES AND BOULDERS	0.0 to 12.0 ft COBBLES AND BOULDERS WITH SILTY SAND: TOTAL SAMPLE (BY VOLUME): About 65% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 10% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 1000 mm.  MINUS 3-inch FRACTION (BY MASS): About 80% fine sand; about 20% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.  IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.  GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)	65	20	10
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
COMMENTS: Discontinued due to limit of equipment.  NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid					

# **APPENDIX 2**

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## SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Pumping Plant 4

Page 1 of 3

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
SAMPLE NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.075mm) to #4 (4.75mm)	GRAVEL #4 (4.75mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - pcf	FILL MOISTURE CONTENT - %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.075mm															
DHSTR7-16-1 SPT#1	20.5-22.0	SM	12.6	27.5	59.9	0.0	0.0	0.0	NA	NP	-	-	2.8	-	2.56	-	-	-	-
DHSTR7-16-1 SPT#2	23.0-24.5	SM	10.9	22.7	66.4	0.0	0.0	0.0	NA	NP	-	-	2.8	-	2.58	-	-	-	-
DHSTR7-16-2 SPT#1	13.0-14.5	(CL)s	50.6	29.0	17.8	2.6	0.0	0.0	38.9	22.4	11.4	-	6.8	2.47	2.57	-	-	-	-
DHSTR7-16-3 SPT#1	18.0-19.5	SM	11.2	27.4	54.6	6.8	0.0	0.0	NA	NP	-	-	3.2	2.33	2.61	-	-	-	-
DHSTR7-16-3 SPT#2	20.5-22.0	SM	6.3	13.0	69.8	10.9	0.0	0.0	NA	NP	-	-	2.2	2.36	2.63	-	-	-	-
DHSTR7-16-4 SPT#1	13.0-14.5	(SM)g	6.1	9.6	55.7	28.6	0.0	0.0	NA	NP	-	-	1.5	2.43	2.57	-	-	-	-
DHSTR7-16-4 SPT#2	15.5-17.0	SM	10.7	24.6	63.0	1.7	0.0	0.0	NA	NP	-	-	2.2	2.42	2.59	-	-	-	-
DHSTR7-16-4 SPT#3	18.0-19.5	SM	10.6	14.2	61.9	13.3	0.0	0.0	NA	NP	-	-	2.5	2.43	2.64	-	-	-	-
DHSTR7-16-4 SPT#4	20.5-22.0	SM	9.3	21.2	61.5	8.0	0.0	0.0	NA	NP	-	-	2.7	2.36	2.63	-	-	-	-

NOTE: Numbers in parentheses are metric equivalents of numbers directly above

## SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Pumping Plant 4

Page 2 of 3

SAMPLE NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES		SAND #200 (0.075mm) to #4 (4.75mm)	GRAVEL #4 (4.75mm) to #10 (2.0mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - pcf	FULL MOISTURE CONTENT - %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.075mm															
DHSTR7-16-7 SPT#1	13.0-14.5	SM	12.5	34.1	53.4	0.0	0.0	0.0	NA	NP	-	-	2.7	-	2.57	-	-	-	-
DHSTR7-16-7 SPT#2	15.5-17.0	s(CL-ML)	23.9	42.3	33.1	0.7	0.0	0.0	22.0	6.1	-	-	3.4	2.56	2.60	-	-	-	-
DHSTR7-16-7 SPT#3	18.0-19.5	(ML)s	24.5	47.6	27.9	0.0	0.0	0.0	20.4	1.8	-	-	3.6	-	2.61	-	-	-	-
DHSTR7-16-8 SPT#1	20.0-1.5	s(CL)	37.5	18.3	40.4	3.8	0.0	0.0	31.0	20.3	-	-	9.0	2.49	2.63	-	-	-	-
DHSTR7-16-9 SPT#1	14.0-15.5	SM	4.1	10.1	73.7	12.1	0.0	0.0	NA	NP	-	-	2.0	2.39	2.59	-	-	-	-
DHSTR7-16-9 SPT#2	19.0-20.5	(GM)s	6.2	13.6	35.0	45.2	0.0	0.0	NA	NP	-	-	2.4	2.46	2.65	-	-	-	-
DHSTR7-16-10 SPT#1	19.0-20.5	SM	10.1	15.7	73.1	1.1	0.0	0.0	NA	NP	-	-	3.7	2.64	2.62	-	-	-	-
DHSTR7-16-10 SPT#2	24.0-25.5	CH	74.8	21.5	3.7	0.0	0.0	0.0	65.8	44.2	4.8	-	17.6	-	2.64	-	-	-	-
DHSTR7-16-12 SPT#1	15.0-16.5	CL	49.0	47.3	3.7	0.0	0.0	0.0	40.9	26.1	12.4	-	8.7	-	2.64	-	-	-	-
DHSTR7-16-12 SPT#2	24.0-25.5	CH	80.1	18.9	1.0	0.0	0.0	0.0	73.0	49.9	4.1	-	16.2	-	2.69	-	-	-	-

NOTE: Numbers in parentheses are metric equivalents of numbers directly above

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Pumping Plant 4

Page 3 of 3

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
SAMPLE NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.074mm) to #4 (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - pcf	FULL MOISTURE CONTENT - %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.074mm															
DHSTR7-16-13 SPT#1	15.4-16.5	CL	56.4	36.8	6.8	0.0	0.0	0.0	44.2	27.1	7.5	-	10.3	-	2.63	-	-	-	-
DHSTR7-16-13 SPT#2	25.0-26.5	CH	88.5	10.4	1.1	0.0	0.0	0.0	68.8	50.3	7.7	-	18.4	-	2.70	-	-	-	-
DHSTR7-16-13 SPT#3	33.5-35.0	CH	66.4	32.9	0.7	0.0	0.0	0.0	56.5	38.2	8.3	-	13.1	-	2.54	-	-	-	-
DHSTR7-16-14 SPT#1	19.0-20.5	(SM)g	7.3	16.9	54.5	21.3	0.0	0.0	NA	NP	-	-	2.8	2.39	2.66	-	-	-	-
TPSTR7-16-2	1.8-2.5	(SM)g	12.4	10.3	61.5	15.8	0.0	0.0	NA	NP	-	95.4	2.9	2.39	2.57	121.9	11.0	1800	78.3

NOTE: Numbers in parentheses are metric equivalents of numbers directly above

# **APPENDIX 3**

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## **Navajo Gallup Water Supply Project**

San Juan Lateral, Pumping Plant 4, Drill Core Photos





























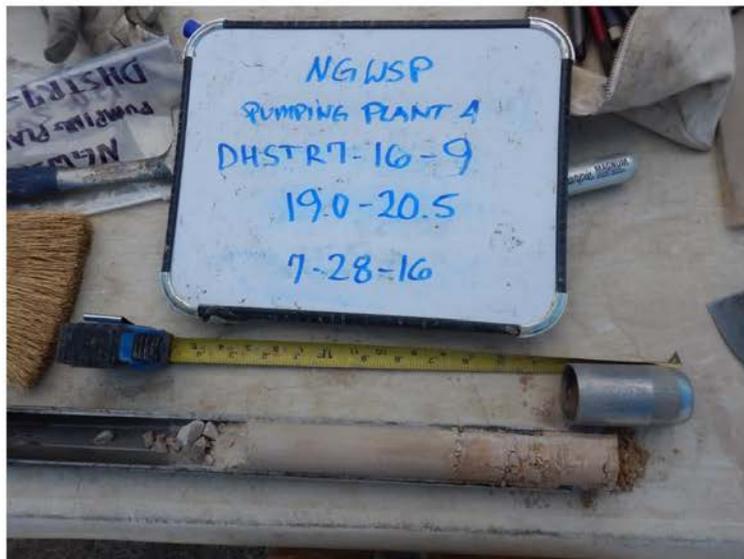




































# Navajo Gallup Water Supply Project

## San Juan Lateral, Pumping Plant 4, Test Pit Photos









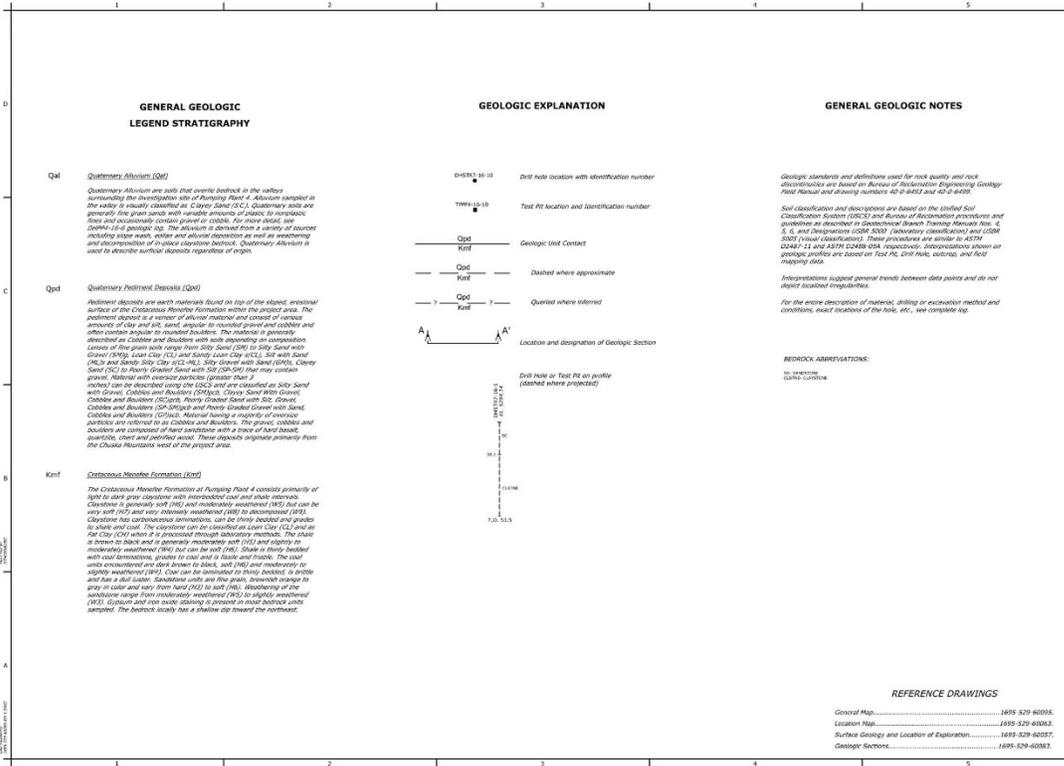




# **APPENDIX 4**

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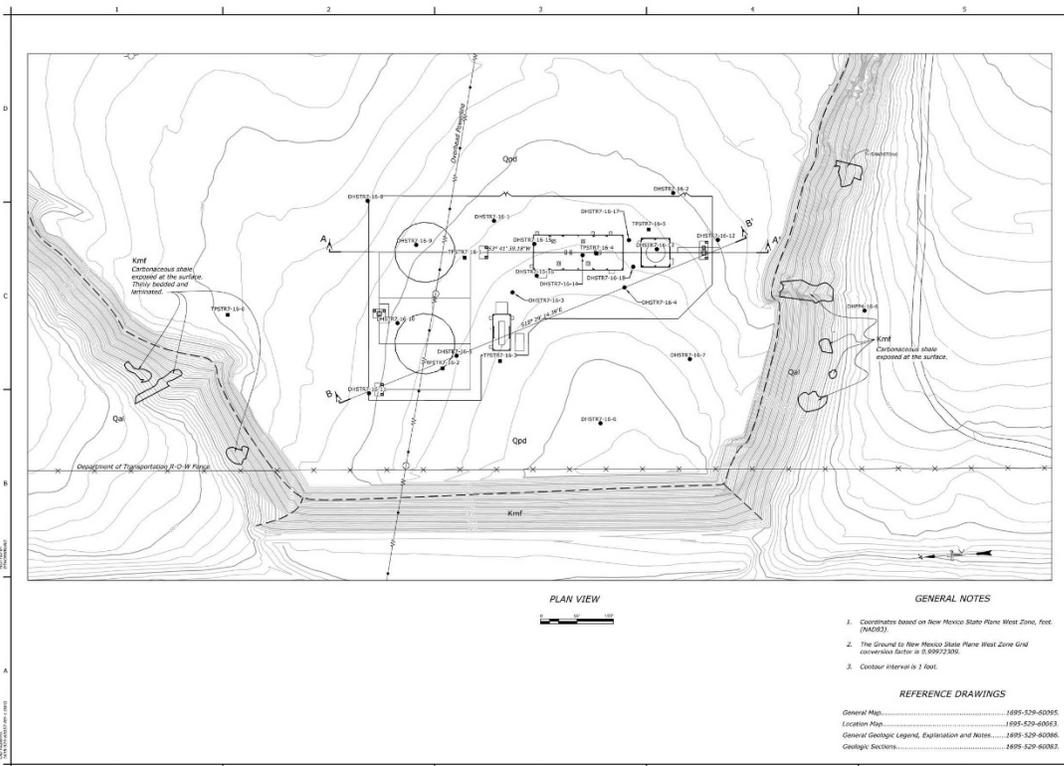
RECLAMATION  
 BUREAU OF RECLAMATION

ALWAYS THINK SAFETY  
 IT'S THE WAY TO LIVE  
 NEW MEXICO  
 SAN JUAN LATERAL  
 PUMPING PLANT NO. 4

DATE: 08/18/11  
 DRAWN BY: J. GARCIA  
 CHECKED BY: J. GARCIA  
 SCALE: AS SHOWN  
 SHEET NO. 1  
 PROJECT NO. 1695-529-6005E

GENERAL GEOLOGIC LEGEND, EXPLANATION, AND NOTES

1695-529-6006E  
 SHEET 1



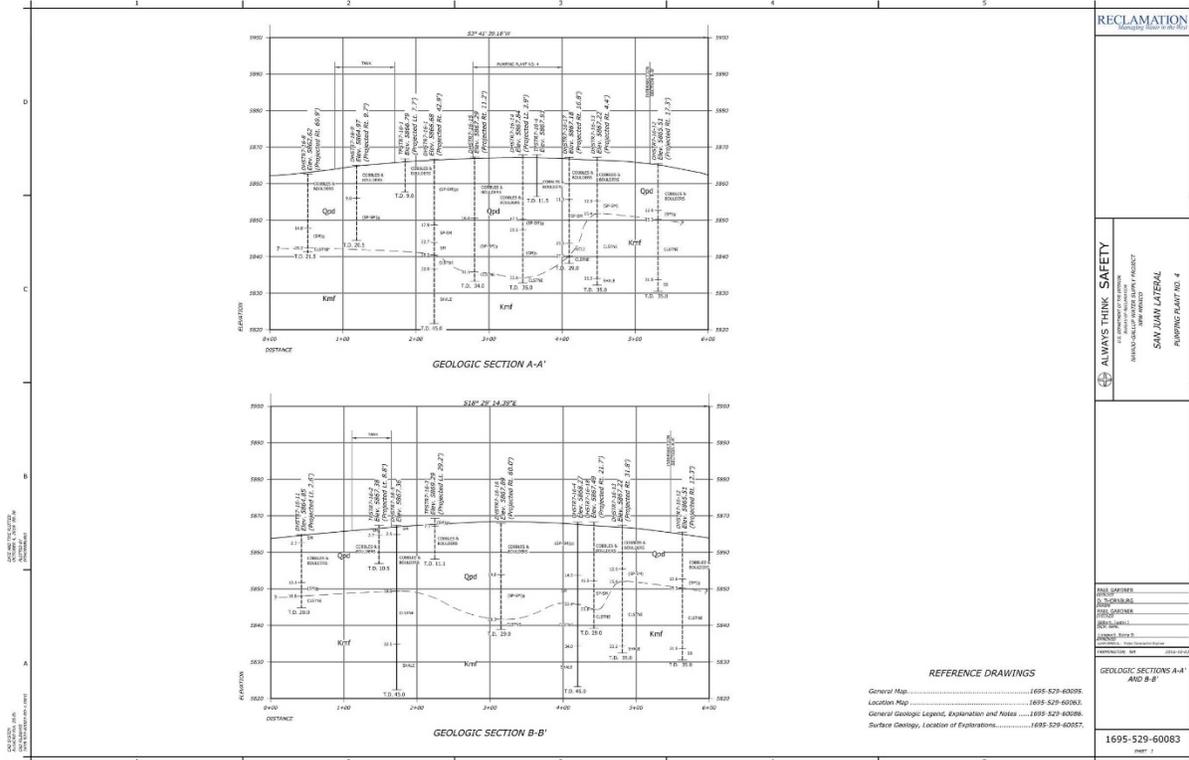
RECLAMATION  
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 NEW MEXICO  
 SAN JUAN LATERAL  
 PUMPING PLANT NO. 4

DATE: 08/18/11  
 DRAWN BY: J. GARCIA  
 CHECKED BY: J. GARCIA  
 SCALE: AS SHOWN  
 SHEET NO. 1  
 PROJECT NO. 1695-529-6005E

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

1695-529-6005E  
 SHEET 1



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PARKLAND-GULF WATER SUPPLY FACILITY  
SAN JUAN LATERAL  
PUMPING PLANT NO. 4

DESIGNED BY	
CHECKED BY	
DATE	
PROJECT NO.	
SCALE	
DATE	
BY	
DATE	
BY	
DATE	
BY	
DATE	

GEOLOGIC SECTIONS A-A'  
AND B-B'

1695-529-60083  
sheet 1

REFERENCE DRAWINGS  
General Map ..... 1695-529-60095.  
Location Map ..... 1695-529-60093.  
General Geologic Legend, Explanation and Notes ..... 1695-529-60099.  
Surface Geology, Location of Explorations ..... 1695-529-60087.

END OF SECTION

**SECTION 53 40 00**  
**PUMPING PLANT 4 – GEOTECHNICAL DESIGN**

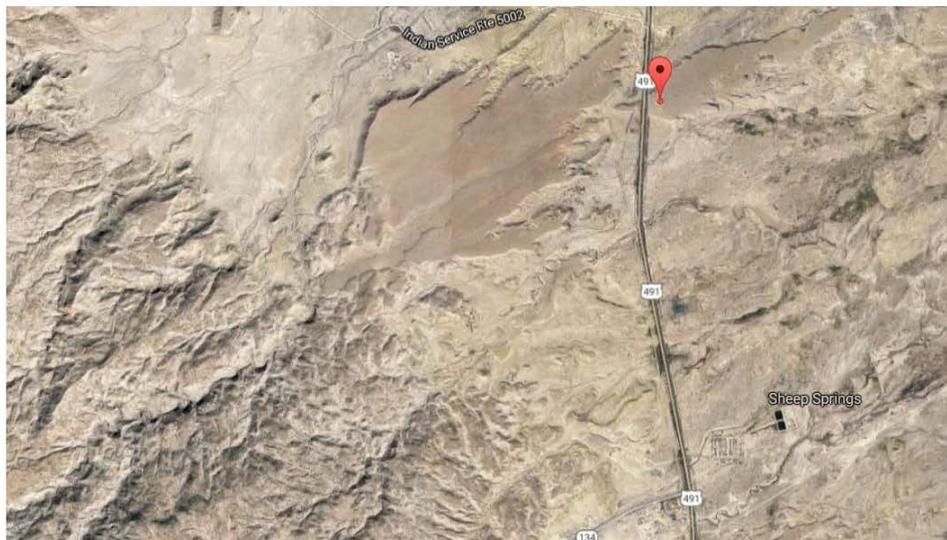
# RECLAMATION

*Managing Water in the West*

Technical Memorandum No. ZN-8314-5

## Pumping Plant 4 – Geotechnical Design

Navajo-Gallup Water Supply Project  
San Juan Lateral, New Mexico



U.S. Department of the Interior  
Bureau of Reclamation  
Technical Service Center

September 2018

**CONTROLLED**

## **Mission Statements**

The mission of the Department of the Interior is to protect and manage the Nation's natural resources and cultural heritage; provide scientific and other information about those resources; and honor its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

**BUREAU OF RECLAMATION**  
Technical Service Center, Denver, Colorado  
Geotechnical Engineering Group 4

**Technical Memorandum No. ZN-8314-5**

**Pumping Plant 4 - Geotechnical Design**  
**Navajo-Gallup Water Supply Project**  
**San Juan Lateral, New Mexico**

Caleb Rudkin, P.E.

Prepared and Technical Approval: Caleb Rudkin, P.E.  
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Checked and Reviewed: Tonya Hart, P.E.  
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Dennis Hanneman, P.E. 9/6/2018

Peer Review: Dennis Hanneman, P.E.  
Geotechnical Engineering Group 1, 86-68311

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

## Technical Memorandum No. ZN-8314-5 Pumping Plant 4 – Geotechnical Design

### I. Executive Summary

This report documents geotechnical aspects of design associated with construction of Pumping Plant 4 and its appurtenant structures. Geotechnical design considerations included mitigation of heave associated with expansive materials, soil settlement associated with new loadings, processing and reuse of foundation materials, and mitigation of corrosion caused by soil/concrete interaction.

#### Expansive Soils/Bedrock

Expansive materials were observed at the site at depths ranging from 13 to 33 feet below the ground surface. After a series of drill holes revealed the presence of expansive claystone, additional drilling was performed to better understand the depth to claystone below key features of the facility. The anticipated bedrock/claystone surface was then modeled, and the site footprint was situated in an attempt to locate the structures in areas where claystone is farthest from the ground surface. It appears that claystone is at shallower depths on the southern and western portions of the site. However, it is acknowledged that the claystone surface is likely to have some variance from what is expected, and it is possible that expansive claystone could be encountered during excavation.

One-dimensional consolidometer testing was performed on samples of the claystone; swell pressures were found to range from 24,000 to 53,000 pounds per square foot (psf), with swell percentages typically ranging from 6 to 13 percent. These values represent the potential for significant heave to occur, should significant quantities of water be able to come into contact the claystone. However, such quantities of water are not anticipated because the claystone surface beneath proposed structures is at depths exceeding 20 feet below the ground surface, particularly if the source of water is precipitation, and if the recommendations provided herein are followed. If claystone is encountered at shallower depths during construction, the expansive materials should be removed to a depth at least 10 feet below foundation bearing elevations, and the design team should be consulted.

The performance of foundations, concrete flatwork and other man-made improvements on sites containing expansive soil and bedrock (collectively referred to as expansive soils) depends upon the response of the expansive soils to

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Pumping Plant 4 – Geotechnical Design**

wetting after construction, as well as the design and construction details made to accommodate this response. Observed structure movements (floors, footings, etc.) can usually be attributed to heave of soils or bedrock within about 20 feet of the ground surface. If the foundation and floor elements are placed on or close to expansive claystone bedrock, they are likely to experience excessive foundation movement (heave) and significant damage.

The mitigation recommendations discussed in this report do not account for excessive flooding or seepage conditions associated with malfunctioning of valves, pipe joints and other appurtenances/components of the water delivery system.

**Coarse Foundation Materials**

The coarse-grained pediment deposit was encountered at ground surface and extended to depths ranging from 12 to 25 feet below the ground surface. This deposit included substantial quantities of cobbles and boulders exceeding 2 feet in diameter. Finer-grained materials (i.e. gravels, sands, silts, and clays) do appear to fill the void spaces between the larger particles, and it is believed that the material can be processed to remove oversized particles in order to produce fill materials appropriate for the areas below and adjacent to structures. However, it should be reiterated that a significant screening process will be required to produce these materials.

Gradations were not performed due to the difficulty associated with performing a gradation on materials of this size.

**II. Project Description**

Pumping Plant 4 is part of the Navajo Gallup Water Supply Project. Construction of infrastructure will allow water to be removed from the San Juan River system, providing a reliable water source to populations within the Navajo Nation, the Jicarilla Apache Nation, and the city of Gallup, New Mexico. The Pumping Plant 4 site is located on a mesa along US highway 491, and serves as the transition location from Reach 7 to Reach 8.

The proposed design for Pumping Plant 4 (PP4) consists of a pumping plant building attached to an air chamber building, two 1-million-gallon water storage tanks, a chemical building, and several subsurface vaults/enclosures for housing flowmeters. A road will be cut through the side of the mesa to provide access to the site from highway 491.

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Pumping Plant 4 – Geotechnical Design**

The proposed pumping plant building is approximately 73 feet long by 46 feet wide. The finished floors are at elevation 5867.5. The structure includes a mat foundation (1 foot thick) with thickened edges around the perimeter (3.5 feet thick) that serve as a spread footing. The pipeline connects to four vertical pump cans, which each extend to 18.8 feet below the top of the slab. Concrete encasements surround the steel pump cans, creating a closed system that reduces the likelihood of water being able to leak into the surrounding foundation materials.

The air chamber room is connected to the pumping plant building. It has a footprint that is approximately 61 feet long by 50 feet wide. It is connected to the pumping plant building, but is offset by 13 feet in the southeast direction. It also includes a mat foundation (1.5 feet thick) with thickened edges (3.5 feet thick). The air chamber equipment is connected to the pipeline at a depth of 8.5 feet below the top of the slab, and all subsurface lines are encased in concrete, providing protection against seepage into the surrounding foundation materials.

The proposed water storage tanks each have a capacity of 1-million gallons. The inside diameter (I.D.) of each tank is 81-feet, and the height is 28 feet. The foundation of the tanks will depend on whether concrete or steel tanks are selected for construction. However, ring foundations are presented in the design drawings. Only a single storage tank is to be installed during initial construction; however, space will be provided to accommodate installation of a second tank in the future.

The proposed chemical building is approximately 33 feet long and 26 feet wide. The finished floor elevation is anticipated to be 5867.5. The structure will be supported by a mat foundation that extends 3 feet below the surrounding ground surface.

Several vaults and manholes, to be constructed out of precast concrete, will also be constructed below grade on the site to provide access to the pipe. The proposed locations of all structures and construction items are shown on Figure 1.

### **III. Geology and Subsurface Conditions**

The following sections (IIIA, III.B, and III.C) were copied verbatim from the Geologic Design Data Report for San Juan Lateral, Pumping Plant 4 [1].

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**CONTROLLED****Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design****A. Regional Geology**

The San Juan Basin is a broad basin that is surrounded by many mountain ranges with distinct geologies including the Chuska Mountains, the La Plata Mtns, the San Juan Mtns, the San Pedro Mtns, the Zuni Mtns. and Mt. Taylor. Characterized by plateaus, mesas and dry-wash canyons presently being eroded in an arid climate, the San Juan Basin is a structural depression that contains Quaternary and Tertiary alluvium, resting on rocks of Tertiary and Cretaceous age which crop out around the margins of the basin. The NGWSP San Juan Lateral is located on the east slope of the Chuska Mountains, near the southwestern margin of the basin north of Gallup, New Mexico. The eastern slope of the Chuska Mountains varies from landslides and pediments to many types of alluvium and mudflats. Bedrock units which outcrop along this portion of the San Juan Lateral are the Cretaceous Menefee Formation. The bedrock is typically covered on the surface by varying amounts of surficial deposits mapped on the surface as Quaternary Alluvium. The Menefee Formation sandstone generally forms cap rock on the hill tops and the softer claystone and shale units form the lower slopes on the hills.

**B. Site Geology**

Pumping Plant 4 is located on a pediment that is a remnant of erosional processes of the Chuska Mountains. Pediments slope gently away from higher elevations and develop when sheet flow erosion occurs during rain fall events. The pediment is flat on top and is flanked by steep, erosional escarpments that facilitate slope wash and alluvial deposition. The pediment is surrounded by low-lying alluvial valley and mud flats. The pediment is resistant to scour and sheet wash by a veneer of gravel, cobbles and boulders referred to as Quaternary Pediment Deposits (Qpd). Rounded to angular gravels, cobbles and boulders with clay and silt are encountered at the pumping plant foundation. Underlying the pediment deposit is the Cretaceous Menefee Formation that consists primarily of claystone, shale and coal.

**C. Stratigraphy**

The geologic units encountered at the Pumping Plant 4 footprint consist of pediment deposits on claystone bedrock. The pediment deposit varies in depth but is generally found within 20 feet of the ground surface. Claystone is the predominant bedrock unit with inter-bedded shale and coal. Sandstone units of the Menefee Formation outcrop on the pediment escarpment and were encountered in subsurface investigation in drill hole DHSTR7-16-12 at 31.8 feet and in drill hole DHPP4-16-6 at 24.5 feet below ground surface.

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Pumping Plant 4 – Geotechnical Design****1. Surficial Deposits****a. Quaternary Alluvium (Qal)**

Quaternary Alluvium (Qal) are soils that overlie bedrock in the valleys surrounding the investigation site of Pumping Plant 4. Alluvium sampled in the valley is visually classified as Clayey Sand (SC). Soils are generally fine grain sands with variable amounts of plastic to nonplastic fines and occasionally contain gravel or cobbles. For more detail, see DHPP4-16-6 geologic log. The alluvium is derived from a variety of sources including slope wash, eolian and alluvial deposition as well as weathering and decomposition of in-place claystone bedrock. Quaternary Alluvium is used to describe these surficial deposits regardless of origin.

**b. Quaternary Pediment Deposits (Qpd)**

Pediment deposits are found on top of the sloped, erosional surface of the Cretaceous Menefee Formation within the project area. The pediment deposit is a veneer of alluvial material and consist of various amounts of clay and silt, sand, angular to rounded gravel and cobbles and often contain angular to rounded boulders. The material is generally described as Cobbles and Boulders with soils depending on composition. Lenses of fine grain soils range from Silty Sand (SM) to Silty Sand with Gravel (SM)g, Lean Clay (CL) and Sandy Lean Clay s(CL), Silt with Sand (ML)s and Sandy Silty Clay s(CL-ML), Silty Gravel with Sand (GM)s, Clayey Sand (SC) to Poorly Graded Sand with Silt (SP-SM) that may contain gravel. Material with oversize particles (greater than 3 inches) can be described using the USCS and are classified as Silty Sand with Gravel, Cobbles and Boulders (SM)gcb, Clayey Sand With Gravel, Cobbles and Boulders (SC)gcb, Poorly Graded Sand with Silt, Gravel, Cobbles and Boulders (SP-SM)gcb and Poorly Graded Gravel with Sand, Cobbles and Boulders (GP)scb. Material having a majority of oversize particles are referred to as Cobbles and Boulders. The gravel, cobbles and boulders are composed of hard sandstone with a trace of hard, basalt, quartzite, chert and petrified wood. These deposits originate primarily from the Chuska Mountains west of the project area.

**2. Bedrock****a. Cretaceous Menefee Formation (Kmf)**

The Cretaceous Menefee Formation at Pumping Plant 4 consists primarily of light to dark gray claystone with interbedded coal and shale intervals. Claystone is generally soft (H6) and moderately weathered (W5) but can be very soft (H7) and very intensely weathered (W8) to decomposed (W9). Claystone has carbonaceous laminations, can be thinly bedded and grades to shale and coal. The

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claystone can be classified as Lean Clay (CL) and as Fat Clay (CH) when it is processed through laboratory methods. The shale is brown to black and is generally moderately soft (H5) and slightly to moderately weathered (W4) but can be soft (H6). Shale is thinly bedded with coal laminations, grades to coal and is fissile and friable. The coal units encountered are dark brown to black, soft (H6) and moderately to slightly weathered (W4). Coal can be laminated to thinly bedded, is brittle and has a dull luster. Sandstone units are fine grained, brownish orange to gray in color and vary from hard (H3) to soft (H6). Weathering of the sandstone range from moderately weathered (W5) to slightly weathered (W3). Gypsum and iron oxide staining is present in most bedrock units sampled. The bedrock locally has a shallow dip toward the northeast.

**IV. Field Explorations**

Geologic investigations (Figure 6) were performed at the site by Reclamation's Four Corners Construction Office (FCCO) geology group and Reclamation's Upper Colorado and Great Plains Drill Crews. The investigations included seven (7) initial exploratory borings (DHSTR7-16-1 through -7) in March of 2016. To better characterize the depths of expansive soils, eleven (11) additional exploratory borings were performed (DHSTR7-16-8 through -18) in July and August of 2016.

The exploratory borings included testing and sampling via Standard Penetration Test (SPT) methods. Blows-per-foot were counted at 5-foot testing intervals and samples were obtained using a split-spoon sampler. Upon reaching materials considered (by on-site geologists) to be potentially expansive soils (claystone or otherwise), a California Modified Sampler was used; this setup consists of a brass liner used within the split-spoon sampler to obtain a "less-disturbed" sample. A total of ninety-two (92) of brass-liner samples were obtained for the purpose of testing both consolidation and swell potential. These samples were sent to Reclamation's Concrete, Geotechnical, and Structural Laboratory (CGSL) in Denver, where swell and consolidation testing were performed on selected samples via one-dimensional consolidometers. Samples obtained using the traditional split-spoon sampler (i.e. no brass-liner) were sent to the Four Corners Construction Office (FCCO) laboratory for material property/index testing.

Six (6) test pits were also dug during the July/August 2016 timeframe. A single in-place density test was performed within these test pits because the materials encountered were generally too coarse to accommodate sand cone testing methods. A sample obtained as part of the density test was also sent to the FCCO laboratory for materials property/index testing.

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Additional exploratory borings were performed along the adjacent Reaches 7 and 8. However, these borings are not discussed within this report.

**A. Field Test Results**

Field test results are provided in the Geologic Design Data Report for San Juan Lateral, Pumping Plant 4 [1]. However, the paragraphs below provide a summary of the results from field testing.

**1. SPT Testing**

SPT tests were not generally performed within the pediment deposit due to the high content of cobbles and boulders. Blows were measured through the sand, silty-sand, claystone, and shale deposits below the pediment deposit. Blow counts were found to be relatively high, as shown in Table 1 below. Out of 52 locations where blow-counts were measured, 96 percent of tests exceeded 30 blows, 71 percent of tests exceeded 40 blows, and 42 percent of tests exceeded 50 blows.

**Table 1. – Distribution of blow-counts from SPT testing**

Number of blows	# of occurrences	Percentage
0-10	0	0.0%
11-20	0	0.0%
21-30	2	3.8%
31-40	13	25.0%
41-50	15	28.8%
>50	22	42.3%

**2. In-place Density Testing**

A single sand-cone density test was performed in test pit TPSTR7-16-2 at a depth of 1.8 to 2.5 feet below the ground surface. Material at this depth was finer than was typically observed on the site, making it suitable for in-place density testing. Unfortunately, the data is not particularly useful since it is not representative of the coarser-grained pediment materials, typical within the upper materials (from ground surface to depths of 12 to 25 feet) across the site.

**3. Geologic Mapping**

The exploration location map, geologic cross sections and geologic logs for exploratory borings and test pits were developed as a result of the geologic

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exploratory program. This information is provided in the Geologic Design Data Report for San Juan Lateral, Pumping Plant 4 [1].

**4. Groundwater**

Since the pumping plant site is on a mesa, groundwater is not expected to be encountered. Consistent with this assumption, groundwater was not encountered within any of the investigations.

**V. Laboratory Testing**

Samples were sent to both the FCCO laboratory in Farmington and the CGSL laboratory in Denver, as described in the Field Explorations section above. All tests were performed in accordance with American Society for Testing and Materials (ASTM) procedures and/or United States Bureau of Reclamation (USBR) procedures.

**A. Swell and Consolidation Testing**

Brass liner samples were sent to Denver for one-dimensional (1-D) swell/consolidation testing. Selected samples were tested based on their proximity to the ground surface; priority was given to samples nearest to the ground surface where swelling soils would be more likely to impact overlying structures.

Thirteen 1-D swell/consolidation tests were performed on intact claystone bedrock specimens. The test results indicate that the on-site claystone is very expansive. Claystone samples exhibited 2.3- to 13.2-percent swell when wetted. Swelling pressures estimated from load-back tests ranged from about 24,000 to 53,000 lb/ft<sup>2</sup>. Swell potential (percentage) and swell pressure were not found to correlate with depth. A summary of results from consolidometer testing is presented as Table 2.

Physical property/index testing was performed on the materials left over from consolidometer testing; test materials included scrap materials from preparation of the consolidometer specimens, and unused materials from adjacent brass liner samples. Gradation tests and atterberg limit tests were performed on these materials; this work was contracted out to Blue Rock Labs out of Littleton, Colorado. Results from these additional tests are presented in section V.B.2 below.

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Table 2. – Summary of results from 1-D swell-consolidation testing

Index 72F- —	Drill Hole DHSTR__	Depth (ft)	w (%)	$\gamma_s$ (pcf)	$\gamma_r$ (pcf)	P.' (psf)	$e_o^*$	C.	Swell (%)	P.' (psf)	P.' (psf)	OCR
156	7-16-2	18.0 - 19.0	12.0	120.9	135.4	2400	0.394	0.16	7.1	32,822	10,831	4.5
157	7-16-2	23.0 - 24.0	17.7	106.5	125.4	3000	0.582	0.29	7.6	24,005	13,467	4.5
170	7-16-4	23.0 - 24.0	16.9	108.4	126.7	3000	0.555	0.24	7.8	42,586	18,293	6.1
175	7-16-5	20.5 - 21.5	17.0	94.6	110.7	2700	0.781	0.34	7.1	26,123	16,409	6.1
176	7-16-5	23.0 - 24.0	13.9	109.3	124.5	3000	0.542	0.27	6.8	37,125	21,226	7.1
177	7-16-5	25.5 - 26.5	12.9	120.7	136.3	3300	0.397	0.11	6.4	47,737	10,162	3.1
178	7-16-5	28.0 - 29.0	21.0	100.5	121.6	3600	0.678	0.23	6.6	37,041	17,317	4.8
188	7-16-6	18.0 - 19.0	9.9	122.9	135.1	2400	0.372	0.09	6.4	53,007	8,609	3.6
189	7-16-6	20.5 - 21.5	11.7	118.2	132.0	2700	0.426	0.18	6.5	27,564	12,026	4.5
190	7-16-6	23.0 - 24.0	14.4	114.9	131.4	3000	0.467	0.45	11.3	31,543	21,797	7.3
191	7-16-6	25.5 - 26.5	18.5	90.0	106.7	3300	0.873	0.20	2.3	46,009	37,575	11.4
201	7-16-7	20.5 - 21.5	13.2	120.8	136.7	2700	0.396	0.19	8.8	41,461	11,840	4.4
202	7-16-7	23.0 - 24.0	17.5	105.0	123.4	3000	0.605	0.45	13.2	30,129	13,270	4.4

\* Void ratios are based on assumed SpG of 2.70

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**B. Physical Properties Testing**

Physical properties testing was performed on all samples sent to the FCCO laboratory. Of the materials sent to CGSL, select samples were sent to Blue Rock Labs for physical properties testing. Tables 3 and 4 provide a summary of all physical properties testing that was performed by both laboratories.

**1. FCCO Laboratory**

Physical properties testing on the samples sent to Farmington included:

- Moisture Content and Dry Density Determination
- Standard Test Method for Particle-Size Analysis of Soils
- Standard Test Methods for Liquid Limit (LL), Plastic Limit (PL) and Plasticity Index (PI) of Soils

Tests were performed on twenty-four samples. Of these samples, ten were classified to be fine-grained (more than 50 percent fines), with samples including both clayey and silty materials. The average liquid limit of the ten samples was measured to be 46, and the average plasticity index was measured to be 28.6.

A single standard proctor compaction test was performed on the sample obtained from the in-place density test. The results of all tests performed by the FCCO laboratory are provided in the Geologic Design Data Report for San Juan Lateral, Pumping Plant 4 [1].

**2. Blue Rock Labs**

Blue Rock Labs performed the same physical properties tests that were performed by FCCO, except that hydrometers were not used for gradation testing. Of these samples, fourteen were classified to be fine-grained (more than 50 percent fines), with samples including both clayey and silty materials. The average liquid limit of the ten samples was measured to be 58.5, and the average plasticity index was measured to be 40.8.

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**Table 3. – Summary of Physical Properties Testing**

Sample # DHSTR__	SPT #	Depth (ft)	USCS	Clay*	Silt*	Sand*	Gravel*	Liquid Limit (%)	Plasticity Index (%)
<b>Test Results from SPT samples (tested by FCCO)</b>									
7-16-1	#1	20.5-22.0	SM	12.6	27.5	59.9	0	NA	NP
7-16-1	#2	23.0-24.5	SM	10.9	22.7	66.4	0	NA	NP
7-16-2	#1	13.0-14.5	(CL)s	50.6	29	17.8	2.6	38.9	22.4
7-16-3	#1	18.0-19.5	SM	11.2	27.4	54.6	6.8	NA	NP
7-16-3	#2	20.5-22.0	SM	6.3	13	69.8	10.9	NA	NP
7-16-4	#1	13.0-14.5	(SM)g	6.1	9.6	55.7	28.6	NA	NP
7-16-4	#2	15.5-17.0	SM	10.7	24.6	63	1.7	NA	NP
7-16-4	#3	18.0-19.5	SM	10.6	14.2	61.9	13.3	NA	NP
7-16-4	#4	20.5-22.0	SM	9.3	21.2	61.5	8	NA	NP
7-16-7	#1	13.0-14.5	SM	12.5	34.1	53.4	0	NA	NP
7-16-7	#2	15.5-17.0	s(CL-ML)	23.9	42.3	33.1	0.7	22	6.1
7-16-7	#3	18.0-19.5	(ML)s	24.5	47.6	27.9	0	20.4	1.8
7-16-8	#1	20.0-1.5	s(CL)	37.5	18.3	40.4	3.8	31	20.3
7-16-9	#1	14.0-15.5	SM	4.1	10.1	73.7	12.1	NA	NP
7-16-9	#2	19.0-20.5	(GM)s	6.2	13.6	35	45.2	NA	NP
7-16-10	#1	19.0-20.5	SM	10.1	15.7	73.1	1.1	NA	NP
7-16-10	#2	24.0-25.5	CH	74.8	21.5	3.7	0	65.8	44.2
7-16-12	#1	15.0-16.5	CL	49	47.3	3.7	0	40.9	26.1
7-16-12	#2	24.0-25.5	CH	80.1	18.9	1	0	73	49.9
7-16-13	#1	15.4-16.5	CL	56.4	36.8	6.8	0	44.2	27.1
7-16-13	#2	25.0-26.5	CH	88.5	10.4	1.1	0	68.8	50.3
7-16-13	#3	33.5-35.0	CH	66.4	32.9	0.7	0	56.5	38.2
7-16-14	#1	19.0-20.5	(SM)g	7.3	16.9	54.5	21.3	NA	NP
<b>Test Results from brass liner samples (tested by Blue Rock Labs)</b>									
7-16-2	72F-156	18-19	CH	98.6	1.4	0	55	39	
7-16-2	72F-157	23-24	CH	99	1	0	58	42	
7-16-4	72F-170	23-24	CH	99.3	0.7	0	73	52	
7-16-5	72F-175	20.5-21.5	CH	99	1	0	68	52	
7-16-5	72F-176	23-24	CH	99.5	0.5	0	74	54	
7-16-5	72F-177	25.5-26.5	CH	99.4	0.6	0	55	41	
7-16-5	72F-178	28-29	CH	96.2	3.8	0	59	43	
7-16-6	72F-186	13-14	g(SM)	27.2	51.6	21.2	NV	NP	
7-16-6	72F-187	15.5-16.5	g(CL)	71.7	8.5	19.8	45	30	
7-16-6	72F-188	18-19	CL	93.7	5.5	0.8	50	36	
7-16-6	72F-189	20.5-21.5	CH	99.8	0.2	0	54	39	
7-16-6	72F-190	23-24	CH	99.7	0.3	0	63	45	
7-16-6	72F-191	25.5-26.5	SC	41.4	58	0.6	52	23	
7-16-6	72F-192	28-29	CL	94.5	5.5	0	42	22	
7-16-7	72F-201	20.5-21.5	CH	98	2	0	56	41	
7-16-7	72F-202	23-24	CH	98.9	1.1	0	73	53	

\*Clay, silt, sand, and gravel sizes in accordance with ASTM C136 and D7928-17

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Table 4. – Summary of physical properties testing on sample from sand cone test

Sample #	Depth (ft)	USCS	Clay	Silt	Sand	Gravel	$\gamma_d$ (pcf)	$\omega$ (%)	$G_s$		$\gamma_d$ max (pcf)	$\omega_{opt}$ (%)	Penetr. Resist. (psi)	D-VALUE (%)
									Plus No. 4	Minus No. 4				
TPSTR 7-16-2	1.8-2.5	(SM)g	12.4	10.3	61.5	15.8	95.4	2.9	2.39	2.57	121.9	11	1800	78.3

### C. Corrosion Testing

The pumping plant structure will be in contact with the concrete structures to depths of nearly 20 feet below the ground surface. Corrosivity testing was performed on eight samples from the site.

Two samples were taken from test pits; the first was at depth of roughly 8.5 feet below ground surface from test pit TPSTR7-16-1. The second sample was taken from a depth of roughly 10 feet below ground surface from test pit TPSTR7-16-4. Both test pits are near the pumping plant structure. Testing of these samples was contracted out to Colorado Analytical Laboratories, Inc. out of Brighton, Colorado, and is provided in Table 5.

Table 5. – Summary of corrosion testing from test pit samples

Sample #	Test Pit	Depth (feet)	Chloride Concentration (mg/L)	Sulfate Concentration (mg/L)	pH
1	TPSTR7-16-1	8.5	121	461	7.7
2	TPSTR7-16-4	10	46	827	7.8

From these results, the following conclusions were made:

- pH for both soil samples were in the “neutral” range ( $5.5 < \text{pH} < 10$ )
- Chloride concentrations fall in the “low” range ( $< 100$  ppm) for one sample and in the “moderate” range ( $100 \text{ ppm} < x < 500$  ppm) for the other soil sample
- Sulfate concentrations fall in the “low” range for both samples ( $< 1000$  mg/L)

Six additional samples were obtained from five drill holes; these samples ranged in depths from 18 to 29 feet below ground surface. The samples were tested at Reclamations CGSL laboratory for chloride concentration, sulfate concentration, and pH. Test results are provided in

**CONTROLLED****Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design****Table 6. – Summary of corrosion testing from drill holes**

Sample #	Drill holes	Depth (feet)	Chloride Concentration (mg/L)	Sulfate Concentration (mg/L)	pH
72F-170	DHSTR7-16-4	23-24	64	1088	5.8
72F-188	DHSTR7-16-6	18-19	79	9250	5.3
72F-192	DHSTR7-16-6	28-29	42	6406	5.2
72F-156	DHSTR7-16-2	18-19	59	280	6.5
72F-201	DHSTR7-16-7	20.5-21.5	67	561	6.1
72F-175	DHSTR7-16-5	20.5-21.5	49	492	5.8

These results yielded the following conclusions:

- pH for soil samples was typically in the “neutral” range ( $5.5 < \text{pH} < 10$ )
- Chloride concentrations fall in the “low” range ( $< 100$  ppm)
- Sulfate concentrations range from “low” ( $< 1000$  mg/L) and “moderate” (1000 to 2000 mg/L) to “severe” (2000 – 20000 mg/L)

The results indicate the need for special considerations on this project pertaining to corrosion of metals and chloride attack on concrete. Due to the moderate sulfate concentration observed, it is advised that all concrete use Type V or Type HS (high sulfate) cement.

## VI. Design

### A. Accommodations for Expansive Materials

Test results from specimens sampled during the March 2016 drilling operations showed claystone deposits to be highly expansive. Drill logs showed top of claystone deposits to vary between 13 feet and 27 feet below ground surface. Claystone at 13 feet would likely be problematic for overlying structures, whereas the hazard for claystone at 27 feet would be much less significant. Preliminary designs therefore included over-excavation of foundation materials, assuming the shallower claystone depths would be encountered. A preliminary idea was also

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proposed of raising the site to create more distance between the lowest points of the structures and the underlying claystone.

To reduce uncertainty about the depth to claystone, additional drill holes (performed in July and August of 2016) were located below the anticipated locations of the key structures. These drill holes provided additional data for modeling and estimating the depth of the top of the claystone surface across the site. The top of the claystone layer was observed to be nearer to the surface on the south and west sides of the site. Based on this observation, it was decided that shifting the footprint of the entire site by about 30 feet to the north would be advantageous; the structure foundations would be located in areas where the claystone is farther below the ground surface (see Figure 7). For this updated site orientation, the claystone deposits are expected to be at least 10 feet below the lowest point of the new structures, and at least 20 feet below the ground surface. Over-excavation is not likely to be necessary based on the geotechnical information available; however, if expansive materials are encountered in excavations then over-excavation and replacement with non- to low-expansive material will be necessary.

Although it is possible that differential heaving could still occur, the shifted site configuration minimizes the hazard associated with differential heaving. Heave analyses were performed to provide an estimate on the amount of heave that could possibly be expected; these analyses are discussed in the paragraphs below.

**1. Heave Analyses**

Analyses were performed to determine the amount of heave that could be expected at several locations throughout the site, including at the pumping plant structure, at the air chamber room area, at the southern-most vault, and at the eastern-most storage tank.

**a. Pumping Plant**

An initial analysis assumed that surficial runoff would be able to infiltrate to a typical depth of 20 feet below the ground surface. However, drill logs show that claystone was encountered at depths ranging from 24 to 34 feet below the pumping plant footprint. If wetting only extends down to 20 feet, claystone would not be encountered, and expansion of the foundation materials would not be a concern.

Wetting to a depth of 25 feet below the ground surface may be reasonable given the coarse nature of the pediment material within the upper 15 feet. However, the soil matrix does not appear to contain large voids, as evidenced in the photographs of the test pits. Rather, finer materials (sand and silt sizes) seem to fill in the voids between the coarser particles. The actual permeability of the

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pediment may therefore be less than what an initial impression would suggest. Wetting to depths of 25 feet or deeper may therefore be considered unlikely, but an analysis with these assumed conditions provides a conservative scenario.

Six drill holes (DHSTR7-16-3 and -14 through -18) provide good evidence as to the depth of claystone below the pumping plant structure. Among these drill holes, DHSTR7-16-3 showed the shallowest claystone surface at a depth of 24 feet. Wetting to a depth of 25 feet will therefore result in swelling of the upper 1 foot of claystone in this area.

The evaluation involved dividing the soil and bedrock profiles into layers and estimating the potential heave characteristics of each layer from representative swell and suction tests results. It was assumed that no swelling occurs in the uppermost layers: the placed structural fill located above the depth of excavation, and the pediment located below the excavation. It was also assumed that no swell occurs in sandstone bedrock deposits. All swelling occurs in the claystone deposits. It was assumed that the claystone will swell by 8 percent, slightly more than the average swell value of 7.5-percent from testing. These assumptions are summarized in the equation below, with variables defined as presented in Table 7:

$$S_{PP4} = 12 * S_F * [(T_1 * S_1) + (T_2 * S_2) + (T_3 * S_3)]$$

**Table 7. – values used in heave analysis**

Layer	Symbol	Description	Value
Layer 1: Structural Fill	T <sub>1</sub>	Thickness of layer 1	14 feet
	S <sub>1</sub>	Percent swell of layer 1	0%
Layer 2: Pediment	T <sub>2</sub>	Thickness of layer 2	10 feet
	S <sub>2</sub>	Percent swell of layer 2	0%
Layer 3: Claystone	T <sub>3</sub>	Thickness of layer 3	1 foot
	S <sub>3</sub>	Percent swell of layer 3	8%

and:

S<sub>F</sub> = swell factor representing actual heave realized at surface, assume 0.7

S<sub>T</sub> = total swell (in inches) at ground surface

The resulting total swell, S<sub>T</sub>, was calculated to be 0.67 inches, within the design tolerance of 1 inch of movement. Furthermore, this analysis assumes all stresses are transferred vertically. Actual vertical heave will be further reduced as stresses are transferred both vertically and laterally, also minimizing the likelihood of heave resulting in differential movements.

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**b. Air Chamber Building**

Initial designs had the air chamber building as being disconnected from the pumping plant and set farther south on the site. Recommendations during the Value Engineering Study resulted in a modification to the design whereby the air chamber building is actually connected to the pumping plant. An initial heave analyses was performed for the updated configuration with the air chamber building (or room) located near DHSTR7-16-13, roughly 7 feet above expansive claystone. However, as discussed above, it was realized that shifting the site 30 feet to the north would move the air chamber footprint away from a localized area where claystone was at a shallower depth. After shifting the site, the depth to claystone is about 17 feet below the bottom of the structure, and about 25 feet below the ground surface.

For this revised location, water is not expected to penetrate down to the claystone. Swell is therefore not expected to be encountered.

**c. Vaults**

There are two valve vaults, one located on the north side of the site, and one located on the south side of the site. The ground surface sits an estimated 25 feet above expansive claystone at the valve vault on the north side of the site. This valve vault is therefore not expected to be subjected to significant heave by the underlying claystone. However, below the valve vault on the south side of the site, claystone sits roughly 16 feet below the proposed final grade elevation. The invert of the structure at this location is roughly 7.5 feet below the ground surface. An analysis was therefore performed to investigate the potential heave of the valve vault at this location. This analysis was performed using the same method described for the pumping plant above. The analysis is represented by the following equation:

$$S_{PP4 \text{ south vault}} = 12 * S_F * [(T_1 * S_1) + (T_2 * S_2) + (T_3 * S_3)]$$

where variables are defined as presented in Table 8:

**Table 8. – Values used in heave analysis for south vault at pumping plant 4**

Layer	Symbol	Description	Value
Layer 1: Structural Fill	T <sub>1</sub>	Thickness of layer 1	9 feet
	S <sub>1</sub>	Percent swell of layer 1	0%
Layer 2: Pediment	T <sub>2</sub>	Thickness of layer 2	7 feet
	S <sub>2</sub>	Percent swell of layer 2	0%
Layer 3: Claystone	T <sub>3</sub>	Thickness of layer 3	9 feet
	S <sub>3</sub>	Percent swell of layer 3	8%

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and:

$S_F$  = swell factor representing actual heave realized at surface, assume 0.7  
 $S_T$  = total swell (in inches) at ground surface

The resulting total swell,  $S_T$ , was calculated to be 6.0 inches. This value is not within the design tolerance of 1 inch of movement. See Section 2 below for recommendations.

**d. Storage Tanks**

It is understood that the foundations for the storage tanks will be designed by the storage tank manufacturer. Expansive claystone appears to be at about 25 feet below the ground surface; this is believed to be a sufficient depth to preclude significant differential heaving below the tank. However, sufficient design should be undertaken to ensure that excessive differential movements do not occur.

**2. Mitigation Below South Vault**

Since expansive claystone is expected to be 7.5 feet below the bottom of the vault (and 16 feet below the ground surface), it is unlikely that sufficient water would actually penetrate to this depth to cause heave of this magnitude. Additionally, the costs associated with potential damage to the structure do not justify the costs associated with the typical mitigation of over-excavation to remove expansive soils. Several feet of expansive soils would have to be removed to provide any benefit. Rather than over-excavating to 10-plus feet below the structure (18-plus feet below ground surface), an alternative solution was provided as a more cost effective solution to mitigate potential heave.

Potential heave will be accommodated by providing a gap space between the manifold piping and the concrete structure; the pipe can move independently of the structure by as much as 4 inches without contacting the concrete structure. This will prevent the structure from damaging the pipe. Additionally, restrained flexible couplings allow for some movement of the pipe itself without inducing critical stresses.

**3. Mitigation Below Water Storage Tanks**

Concrete water storage tanks are at particular risk because leakage incidents are most common at these structures, and provide a significant potential for water to be introduced into the foundation. At pumping plant 4, the claystone is likely at

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depths exceeding 15 feet (below existing ground surface) at the water tank locations.

The foundation below the concrete tanks was designed to include a drainage system. The design intent of this system is two-fold: 1) it provides for the detection and monitoring of leakage, allowing it to be conveyed away from (rather than into) the foundation, and 2) it protects the tank from heave associated with expansion of the claystone by limiting the quantity of water that could enter into the foundation.

The drainage system was designed to have the concrete tank structures founded on 12 to 18 inches of gravel drain material (see Figures 1 through 4), with the gravel material underlain by a geomembrane liner. The subgrade below the liner is sloped to convey seepage toward the perimeter of the tanks, where a drain pipe can collect water and convey it off-site.

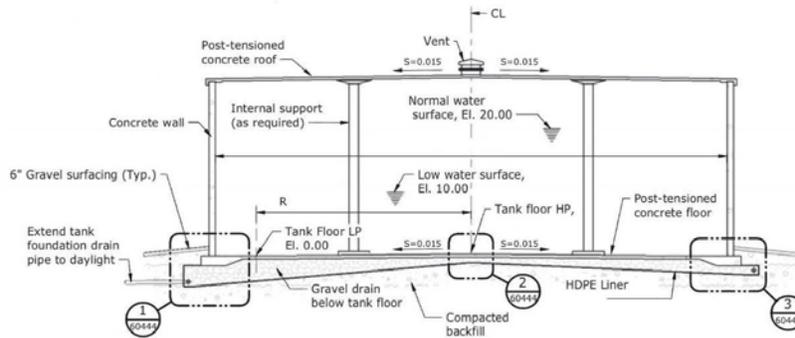


Figure 1. – Figure showing typical foundation beneath water storage tanks

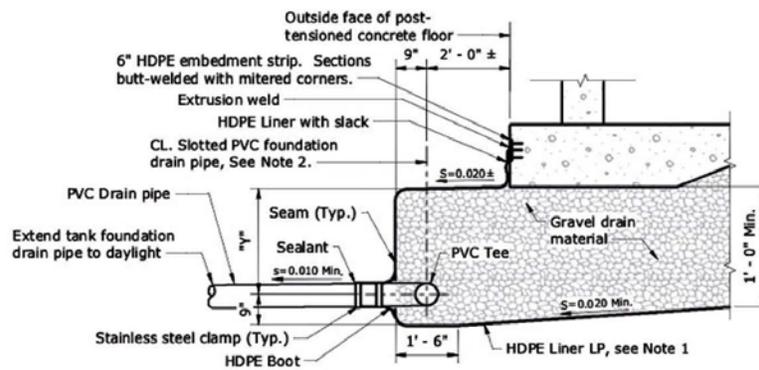


Figure 2. – Detail showing outlet from tank foundation drain pipe

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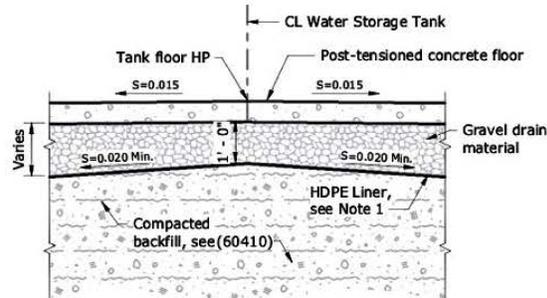


Figure 3. – Detail showing tank foundation drain at center

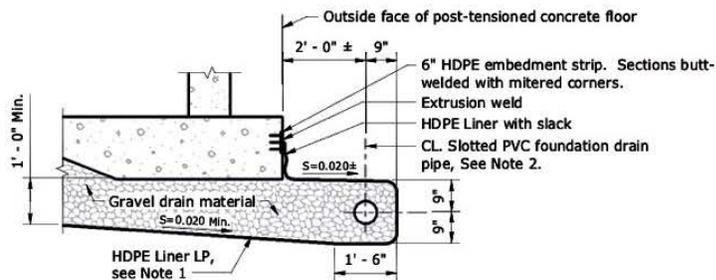


Figure 4. – Detail showing high point of tank foundation drain pipe

## B. Material Parameters for Design

Material strength parameters were provided to the design team for use in structural design (i.e. bearing capacity analyses, thrust block design, settlement calculations, quantity calculations, etc.). However, since shear strength tests were not performed in a laboratory setting, strength parameters were provided based on material correlations. SPT blow-counts were correlated to unit weight as well as friction angle using guidance from Fang's Foundation Engineering Handbook [2]. Correlations were also based on the general material types encountered, using guidance from Reclamation's Design of Small Dams [3].

It is anticipated that excavation for new structures will extend two feet below the lowest points of the structures. This will allow for removal of soft or oversize particles immediately below the structure. Structural fill material will then be placed above the excavated surface and around the structures.

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Material properties were provided for two representative materials: an in-situ foundation material and a structural fill material. The in-situ foundation material is primarily representative of the coarse pediment deposits, although it also may be considered to represent the sandier foundation soils found in several areas. A summary of material properties used in design is also provided in Table 9.

**Table 9. – Summary of Material Properties**

	<b>Foundation Material</b>	<b>Structural Fill</b>
Dry Unit Weight (lb <sup>3</sup> /ft)	120	120
Moisture content (%)	3	10
Bearing capacity (lb/ft <sup>2</sup> )	4,000	4,000
Modulus of Subgrade Reaction (ksf/ft)	200 - 500	150-300
Cohesion (psi)	0	0
Friction Angle (degrees)	36	36
OSHA Classification for Excavation Slopes	Type C (1.5H:1V, or flatter)	Type C (1.5H:1V, or flatter)

**1. Foundation Material**

The foundation material was assumed to represent the pediment material generally found to a depth of 12 to 15 feet. The pediment material is composed primarily of cobbles and boulders with silty sand and gravel, although there were some lenses of finer materials, primarily silty sand. In-place density tests were not able to be performed due to the large particle sizes, except for at a single location where finer materials were encountered near the surface. SPT blow counts were very high, but are probably unreliable due to interference from gravel and other oversize particles.

**a. Unit Weight and Moisture Content**

Dry unit weight was therefore estimated (conservatively) based on SPT correlation tables provided in Gunaratne's The Foundation Engineering Handbook [4]. A dry unit weight of 120 lb/ft<sup>3</sup> was estimated, conservatively correlating to a dense sand (at roughly 30 blows). Test pits in this material also revealed the material to be in a very dense state; it is likely that the dry unit weight is even higher.

Materials obtained from the test pit and from SPT testing were found to have an in-situ moisture content of about 3 percent. Total unit weight was therefore estimated to be about 125 lb/ft<sup>3</sup>.

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Bearing capacity was estimated based on correlations from “NAVFAC” Design Manual 7.01 [5], for gravel-sand mixtures in a medium to compact condition. Although guidance recommends a value of 10 kips per square foot (ksf), it was decided to provide additional factor of safety and reduce the recommended bearing capacity to 4 ksf (4,000 lb/ft<sup>2</sup>) which does not present any difficulty for the structural design.

**c. Modulus of Subgrade Reaction**

Modulus of subgrade reaction ( $k_s$ ) was provided to be 200-500 ksf/ft based on correlations from Bowles [6], for a medium-dense sand.

**d. Cohesion and Friction Angle**

Cohesion was assumed to be zero assuming the finer materials consist entirely of silts. Friction angle ( $\Phi$ ) was provided to be 36 degrees based on correlations made using Reclamation’s Design of Small Dams [3]. Friction angle was estimated based on the average values of several compacted materials: poorly-graded gravel, silty gravel, poorly-graded sand, and silty sand.

**e. OSHA Material Type for Excavation**

The foundation material is conservatively assumed to classify as a Type C soil per OSHA regulations, requiring excavation slopes of 1.5:1 (H:V) or flatter.

**2. Structural Fill**

After excavating to 2 feet below the bottom of each structure, structural fill will be placed up to the bottom of the surface, and then up to the final grade. The structural fill is to be processed from the excavated materials by screening it to remove particles larger than 3-inches in diameter. The structural fill material will therefore consist of a well-graded mixture of gravel, sand, silt, and clay particle sizes.

Gradations were not performed on a representative sample of pediment material; SPT samples captures the finer particle sizes, but did not account for larger gravel particles, cobbles and boulders. Best estimates of the material composition are therefore made by visual observations of the test pits. Photographs of the test pit materials are presented in the Pumping Plant 4 Geologic Design Data Report [1]. From these photos, it is estimated that 25 to 50 percent of the materials are oversized particles (greater than 3-inch diameter) that will need to be screened

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out. The remaining materials would likely be classified as a silty-sand or a well-graded sand.

**a. Unit Weight and Moisture Content**

Dry unit weight was conservatively estimated to be 120 lb/ft<sup>3</sup> based on correlations for compacted materials, by material type, using Reclamation's Design of Small Dams [3]. Given the moderate fines content, it is assumed that the optimum moisture content is around 10 percent. This value will be field tested during quality control activities during compaction of materials. Total unit weight is estimated to be about 132 lb/ft<sup>3</sup>.

**b. Bearing Capacity**

Bearing capacity was estimated based on correlations from "NAVFAC" Design Manual 7.01 [5], for gravel-sand mixtures in a medium to compact condition. As was done for the foundation material, a bearing capacity to 4 ksf (4,000 lb/ft<sup>2</sup>) was recommended.

**c. Modulus of Subgrade Reaction**

Modulus of subgrade reaction ( $k_s$ ) was provided to be 150-300 ksf/ft based on correlations from Bowles [6] for a silty, medium-dense sand.

**d. Cohesion**

Cohesion was assumed to be zero assuming the finer materials consist entirely of silts. Friction angle ( $\Phi$ ) was provided to be 36 degrees based on correlations made using Reclamation's Design of Small Dams [3].

**e. OSHA Material Type for Excavation**

The structural fill material is conservatively assumed to classify as a Type C soil per OSHA regulations, requiring excavation slopes of 1.5:1 (H:V) or flatter. However, it is not expected that excavation will occur within the structural fill.

**C. Liquefaction Potential**

Liquefaction is not considered to be a design concern. The water table was not encountered during investigations and is not expected to fluctuate on the mesa. Liquefaction would therefore be unable to occur during seismic activity.

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## VII. Summary and Discussion

Pumping Plant 4 and its appurtenant structures are to be constructed on a strong foundation consisting primarily of coarse pediment materials. The materials are very coarse, but provide a high allowable bearing capacity for the structures. Excavation should proceed to 2 feet below the bottom of each structure to ensure that a firm, flat foundation can be built up using structural fill material.

Structural fill material will be composed of processed pediment materials, with screening to remove oversize particles. Materials within 1 foot of the manifold piping are to have a maximum size of 3/4-inches. Materials placed within 3 feet of structures are to have a maximum particle size of 3 inches. Materials not within 3 feet of structures may contain particle sizes up to 6 inches. Materials with particles in excess of 6-inch-diameter may be placed as rockfill at the bottom or outer slopes of the fill used for construction of the access road. Additionally, materials within 2 feet of a structure should have special compaction.

Expansive claystone materials are present below the site, but are considered to be at sufficient depth such that surface heave is calculated to be less than 1 inch in most areas. At the south vault, the potential for greater heaving is addressed by providing measures to accommodate some movement.

It should be emphasized that there is risk involved in the construction of building and infrastructure in an area where expansive claystone bedrock is present at a shallow depth. Furthermore, due to geologic variability and uncertainties, it is impossible to predict the actual magnitude of heave and when it may occur. *If expansive materials are encountered, the design team should be immediately contacted to allow for appropriate design adjustments.*

A gravel drain system has been incorporated into the design to minimize the potential for damage to the water storage tanks due to soil expansion. The gravel drain system includes an HDPE geomembrane, allowing water leaking through the tanks to be collected and conveyed away from the foundation.

Additional measures are also included in the design to reduce the likelihood of damaging heave caused by expansive materials. The structures include gutters to collect precipitation and convey it away from the structures. Within ten feet of structures, the ground surface should be sloped at a minimum of 5 percent to reduce infiltration adjacent to the structures. The site will be graded to ensure drainage away from the structures and off-site. These measures are intended to minimize the amount of precipitation that finds its way into the foundation materials.

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Lastly, it is advised that all concrete structures use Type V or Type HS (high sulfate) cement, due to the moderate sulfate concentration observed in soil samples.

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## References

- [1] "Geologic Design Data Report, San Juan Lateral, Pumping Plant 4," Navajo Gallup Water Supply Project, Bureau of Reclamation, Upper Colorado Region, Four Corners Construction Office, October 2016.
- [2] H.-Y. Fang, *Foundation Engineering Handbook*, Springer US, 1991.
- [3] *Design of Small Dams*, U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, 2015.
- [4] M. Gunaratne, *Foundation Engineering Handbook*, 2nd ed., New York City: Crc, 2006.
- [5] "Soil Mechanics Design Manual 7.01", Naval Facilities Engineering Command, September 1986.
- [6] J. E. Bowles, *Foundation Design and Analysis*, 5th ed., New York: McGraw-Hill, 2001.
- [7] K. Terzaghi, "Evaluation of Coefficients of Subgrade Reaction," *Geotechnique*, vol. V, no. 4, pp. 41-50, 1955.

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## **Figures**

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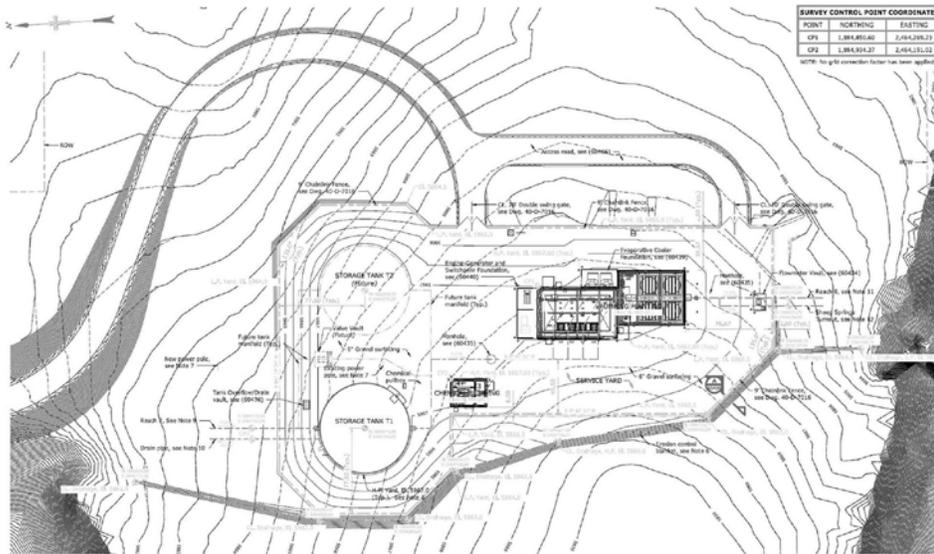


Figure 5. – Site plan for Pumping Plant 4

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## Appendix A - Recommendations

The recommendations in this appendix are based on the results of field explorations and laboratory testing. It is possible that subsurface conditions can vary between or beyond the points explored. If the subsurface conditions found during construction differ from those described in the geology section of this report, please notify Reclamation immediately so that we can review our report in light of those conditions in order to provide supplemental recommendations as necessary.

The report was prepared in substantial accordance with the generally accepted standards of practice for geotechnical engineering as exist in the project area at the time of this technical memorandum.

### 1. *Site Preparation and Grading*

#### **Subgrade**

After performing the required excavations and prior to the placement of fill, the excavated surface should be prepared. Any boulders along this surface should be removed and backfilled with compacted fill. If the excavated surface is not within pediment deposit, it should be scarified to a depth of at least 8 inches, and compacted to a minimum of 95-percent of maximum density, as determined using the modified proctor test.

#### **Excavation Slopes**

It is expected that both the pediment material and the weathered/decomposed claystone and bedrock materials will classify as Type C materials using OSHA criteria. OSHA requires that unsupported cuts up to 20-feet in height be laid back to ratios no steeper than 1.5H:1V (horizontal:vertical) for a Type C material. In general, these excavation slope ratios will be stable under temporary, unsaturated conditions. However, if runoff drains into the excavation, flatter slopes may be more appropriate. The actual determination of soil type and allowable sloping must be made in the field by an OSHA-qualified "competent person."

#### **Final Grading**

Positive drainage away from the structures is essential to the performance of foundations, floor slabs and flatwork, and should be provided during the life of the structures. Landscape areas should not be within 10 feet of the structures. Areas where pavements or slabs are constructed adjacent to the structures should slope away at a minimum grade of 5 percent within 10 feet of the structure. All downspouts from roof drains should cross all backfilled areas such that they discharge all water away from the backfill zone and the structure. Drainage

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should be created such that water is diverted off the site and away from adjacent buildings.

**Miscellaneous**

All site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations, and other local, state or federal guidelines.

Site preparation should consist of clearing and grubbing topsoil, organic matter, and removal of deleterious material from areas to be filled and cut.

Topsoil, vegetative, and deleterious material should be removed for offsite disposal in accordance with local laws and regulations.

Screened boulders and cobbles should be wasted or used on-site. However, they should be placed a minimum of 30 feet away from buildings; if used closer, they would allow excessive moisture to infiltrate into the foundation below the structure.

**2. Structural Fill**

The structural fill is to be processed from the excavated materials. Excavated claystone materials are not to be used for structural fill, unless properly processed, mixed, and moisture conditioned. The structural fill should be low permeability and non-expansive, with a maximum swell potential of 1-percent or less under 1,000-pounds per square foot (psf) of surcharge when inundated with water. Additional moisture conditioning may be required during placement and compacting of structural fill.

The structural fill should be placed on a horizontal plane and placed in loose lifts not to exceed 6-inches in thickness. Structural fill is to be compacted to a minimum of 95-percent of maximum density, as determined using the modified proctor test. Moisture content is to be between optimum and 3-percent above optimum.

It is recommended that a low-permeability “cap” be placed within the top 3-feet of the ground surface around the structures; this will hinder infiltration of surface water below the structures, minimizing the potential for heave.

A Reclamation representative should be on-site during construction to observe preparation of the site, excavation for the buildings and storage tanks, and to test structural fill placement.

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During construction, grade the site such that surface water can drain away from the construction areas free of obstructions. Promptly pump out or otherwise remove any water that may accumulate in excavations or on subgrade surfaces, and allow these areas to dry before resuming construction. Berms, ditches, and similar means may be used to prevent stormwater from entering the work area, and to convey water off site efficiently.

If earthwork is performed during the winter months when freezing is a factor, no non-structural grading fill, structural fill or other fill should be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to fill placement. A good practice is to cover the compacted fill with a “blanket” of loose fill to help prevent the newly placed structural fill from freezing.

If the building is erected during cold weather, foundations, concrete slab-on-grade floors, or other concrete elements should not be constructed on frozen soil. Frozen soil should be completely removed from beneath the concrete elements, or thawed, scarified, moisture-conditioned, and re-compacted. The amount of time passing between excavation or subgrade preparation and placing concrete should be minimized during freezing conditions to prevent the prepared soils from freezing. Blankets, soil cover or heating as required may be utilized to prevent the subgrade from freezing.

**4. Mitigation for Potential Heave if Expansive Materials are Encountered**

Recommendations for mitigation of expansive materials are provided in the main body of the report. Additional recommendations are presented below.

For a shallow foundation system such as a reinforced mat foundation, a currently accepted mitigation technique for expansive soil sites is over-excavation of at least 10-feet below the bottom of the lowest foundation elements (i.e. the bottom of the pipe encasement for the pumping plant building). The over-excavation should also extend at least 10-feet laterally outward from the edge of the mat foundation; the 10-foot lateral extension of the foundation excavation should be measured at the bottom of the mat foundation excavation. The side slopes of the over-excavation should conform to OSHA requirements. The structural fill should be placed in the over-excavated area to support the mat foundation. The intent of constructing the mat foundation on at least 10-feet of structural fill is to reduce differential movements across the structure to about 1-inch. In order to achieve this result, careful construction and an adequate amount of testing during

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structural fill placement will be required. Testing should include moisture/density testing as well as swell testing of the structural fill.

**5. Reinforced Mat Foundation for Pumping Plant Building**

1. It is recommended that the multiple pipe joints system be designed to accommodate differential vertical movement of at least 1 inch.
2. In order to minimize differential settlements at the expansion joint location between building units, structural measures such as rebar dowels, etc. should be utilized at those locations.
3. Water pipes and other utility lines within the pumping plant building should be carefully leak tested after installation.
4. At the perimeter of the mat foundation, it is recommended to have at least 30 inches of soil cover above the bottom of the mat foundation for frost protection per local building department requirements.
5. The foundation subgrade and compacted structural fill should be protected from wetting and drying prior to, and after concrete placement. Foundation should be backfilled as soon as practical after concrete placement.
6. Landscaping that requires supplemental watering should not be established within 10 feet of the pumping plant building, slabs pavements, etc. Those areas may be covered with decorative gravel.

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## **Appendix B – Plan View With Borehole Locations**

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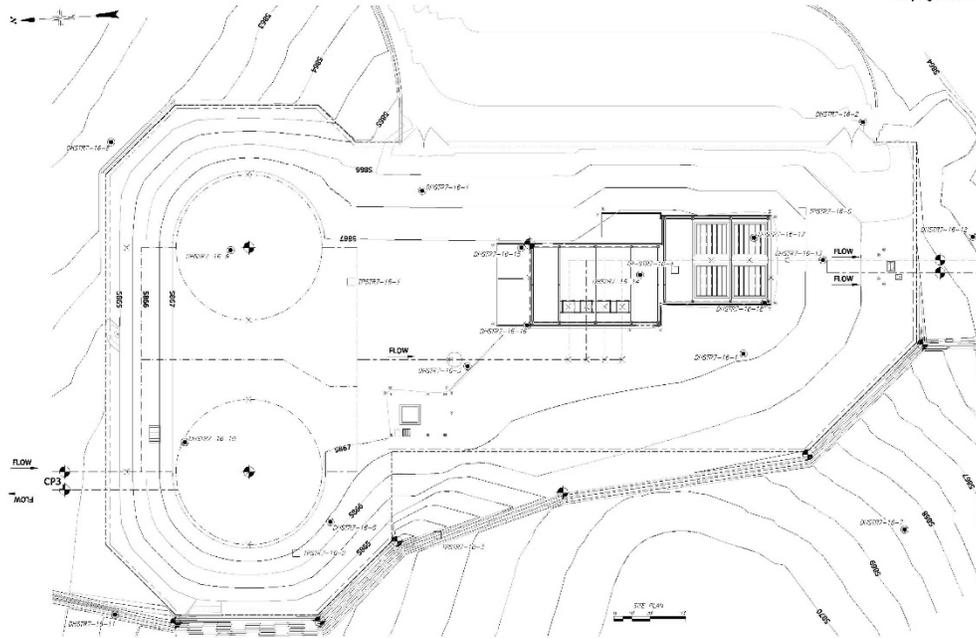


Figure 6. – Plan view showing drillhole and test pit locations (final surface shown)

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## **Appendix C – Projected Bedrock Surface**

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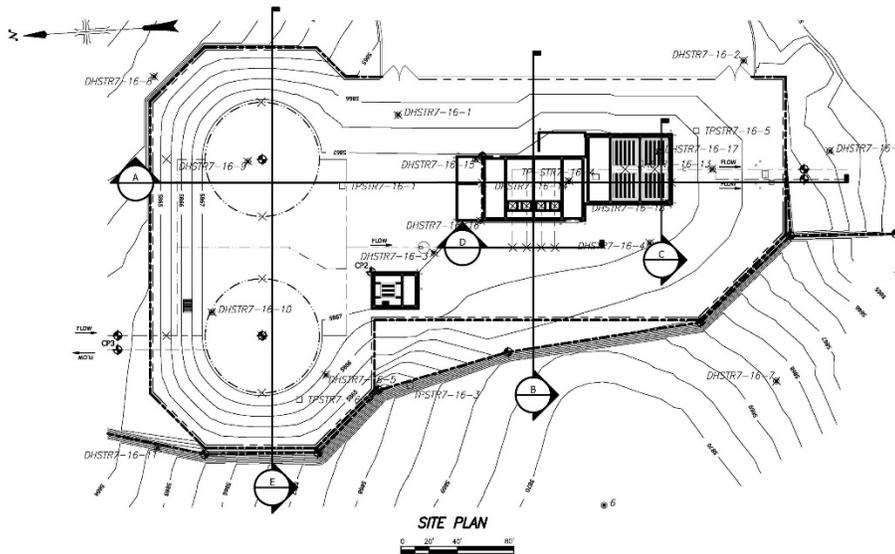


Figure 7. – Site plan showing locations of cross sections

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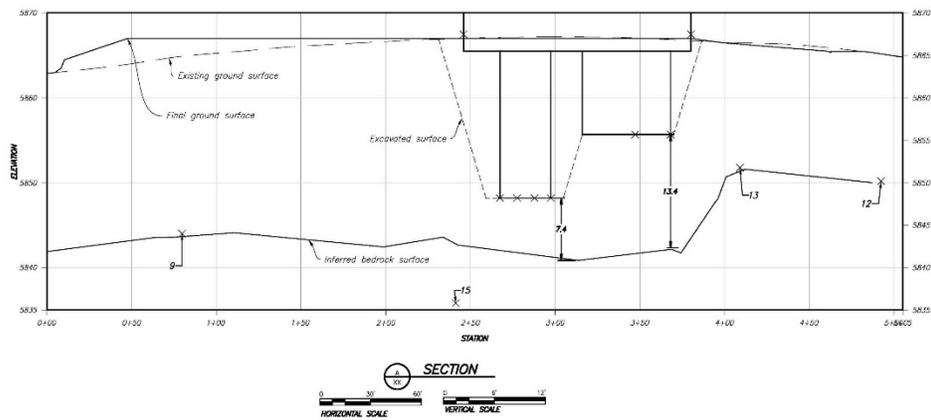


Figure 8. – Sections A (note, 5x vertical exaggeration)

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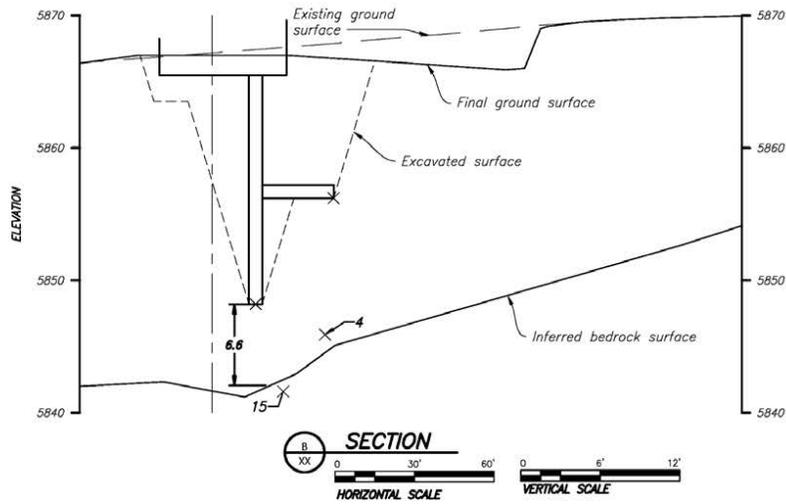


Figure 9. – Section B (note, 5x vertical exaggeration)

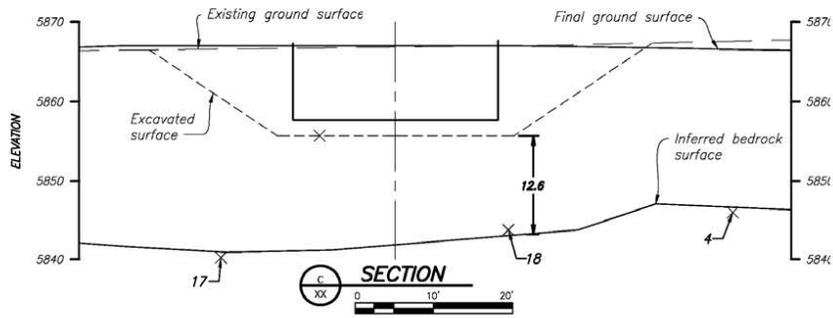


Figure 10. – Section C

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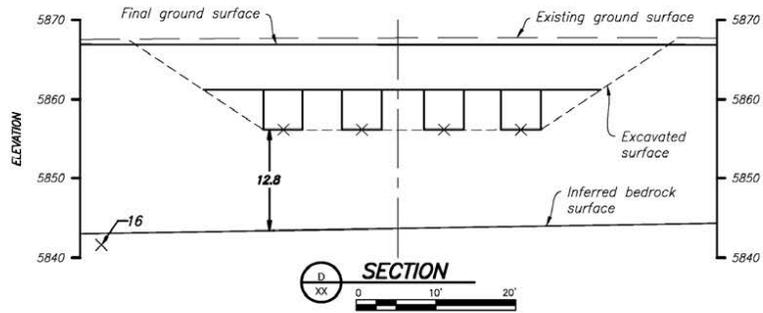


Figure 11. – Section D

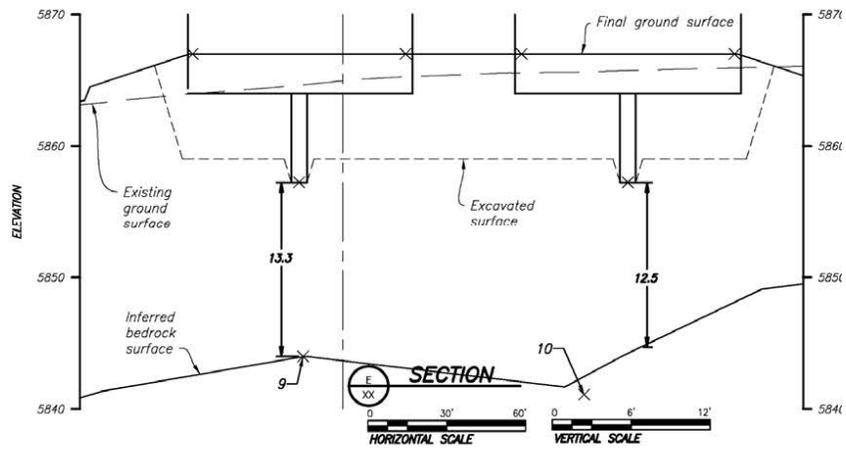


Figure 12. – Section E (note, 5x vertical exaggeration)

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## **Appendix D – Typical Sections**

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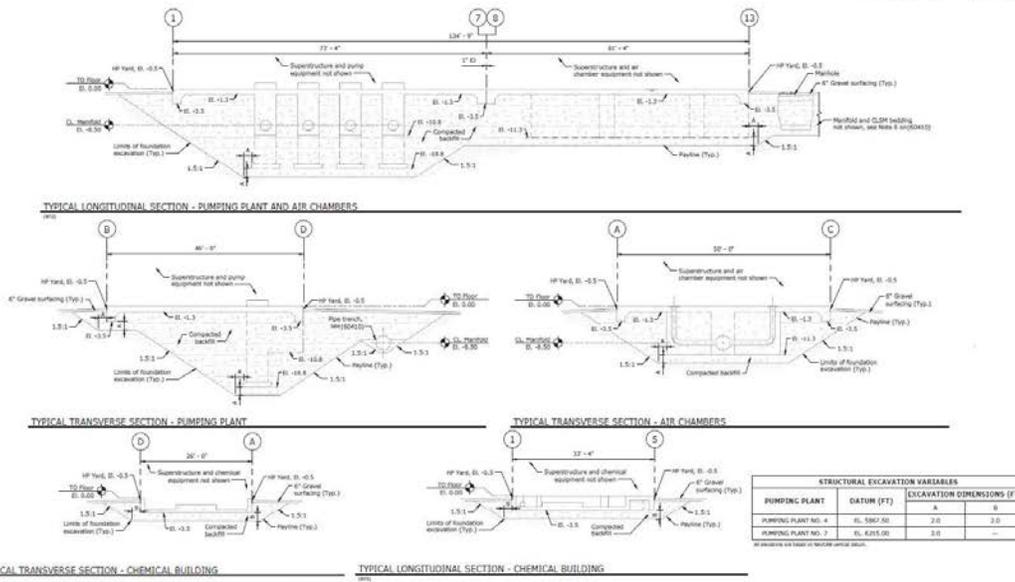


Figure 13. – Typical sections through structures at Pumping Plants 4 and 7, with relative elevation data (from draft version of drawing 1695-D-60409)

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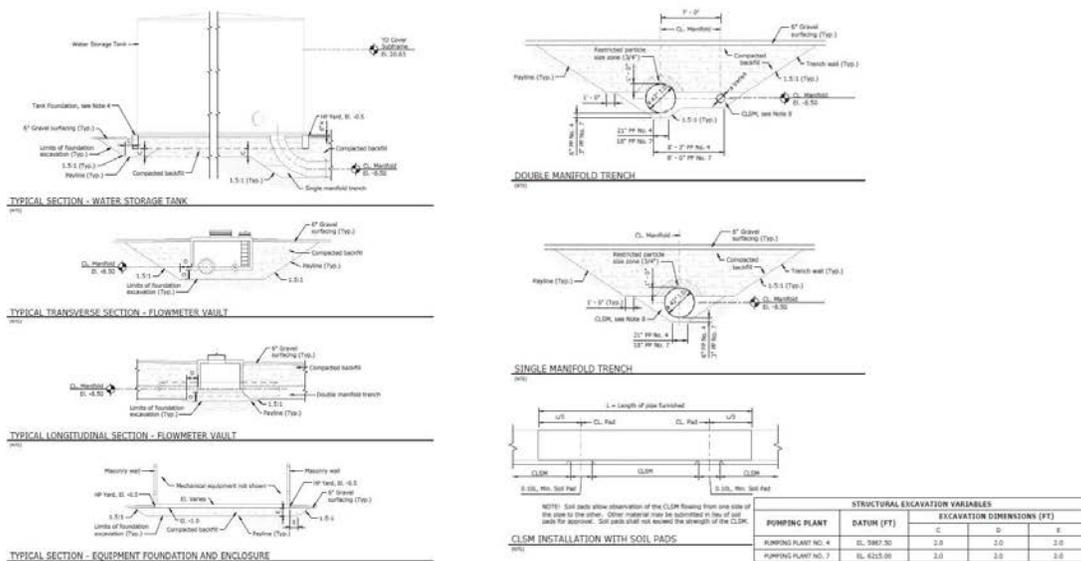


Figure 14. – Typical sections through structures at Pumping Plants 4 and 7, with relative elevation data (from draft version of drawing 1695-D-60410)

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## **Appendix E – Drill Hole Logs**

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GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-1													SHEET 1 OF 1			
FEATURE: Pumping Plant 4			PROJECT: Navajo Callup Water Supply Project				STATE: New Mexico									
LOCATION: Site Investigation			COORDINATES: N 1,884,908.3 E 2,464,300.9 N.M. State Plane				GROUND ELEVATION: 5866.7 ft. MAD-83									
BEGIN: 3/25/16 FINISHED: 3/25/16			TOTAL DEPTH: 45.0				ANGLE FROM HORIZONTAL: -90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 26.2				HOLE LOGGED BY: C. Beyer									
DATE MEASURED: 3/25/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILLEBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG</p> <p>DRILL METHOD: 0.0 TO 8.0 FT: 4 1/4" SSA WITH PILOT BIT 8.0 TO 10.3 FT (REFUSAL): 4 1/4" HSA AND DRY CORE SYSTEM 10.3 TO 13.0 FT: 4 1/4" SSA WITH PILOT BIT 13.0 TO 18.0 FT: 4 1/4" HSA AND DRY CORE SYSTEM 18.0 TO 19.0 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER (ASSUMED CLAYSTONE) 19.0 TO 24.5 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS 24.5 TO 45.0 FT: HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT: NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT. NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE AND CUTTINGS.</p> <p>SAMPLING: 18.0 TO 19.0 FT: CALIFORNIA SAMPLE (DISCARDED) 23.5 TO 22.0 FT: SPT 23.0 TO 24.5 FT: SPT 28.0 TO 28.0 FT: CALIFORNIA SAMPLE 30.5 TO 31.5 FT: CALIFORNIA SAMPLE 33.0 TO 34.0 FT: CALIFORNIA SAMPLE 35.5 TO 36.5 FT: CALIFORNIA SAMPLE 38.0 TO 38.0 FT: CALIFORNIA SAMPLE 40.5 TO 41.5 FT: CALIFORNIA SAMPLE 43.0 TO 44.0 FT: CALIFORNIA SAMPLE</p>	5	PILOT													0.0 TO 26.2 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)	
		10	PILOT													0.0 TO 17.9 FT POORLY GRADED SAND WITH SILT, GRAVEL AND COBBLES (SP-SM)gc; ABOUT 50% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND; ABOUT 30% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY, AND NO DRY STRENGTH, GRAY IN COLOR, DRY, STRONG REACTION WITH HCl.
		15	Qpd													TOTAL SAMPLE (BY VOLUME): ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES, REMAINDER MINUS 3-INCH, MAXIMUM SIZE, 200mm.
		16/20														17.9 TO 22.7 FT POORLY GRADED SAND WITH SILT (SP-SM); ABOUT 90% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL, MAXIMUM SIZE, 20mm; DRY, BROWN IN COLOR, STRONG REACTION WITH HCl.
		20														22.7 TO 26.2 FT SILTY SAND (SM); ABOUT 85% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND; ABOUT 15% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL, MAXIMUM SIZE, 25mm; DRY, GREY IN COLOR; NO REACTION WITH HCl.
		25														26.2 TO 45.0 FT CRETACEOUS MENEPEE FORMATION (Kmf)
		26.2														26.2 TO 30.0 FT CLAYSTONE; VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W5), FROM 26.2 TO 28.7 FT. SOFT (H6) AND MODERATELY WEATHERED (W5) FROM 28.7 TO 30.0 FT. GREY IN COLOR; MOTTLED, LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.
		30														30.0 TO 45.0 FT SHALE; SLIGHTLY FISSILE, SLIGHTLY TO MODERATELY WEATHERED (W4); MODERATELY SOFT TO SOFT (H5-H6), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING, NO REACTION WITH HCl.
		35														END OF HOLE, TOTAL DEPTH=45.0
		40														STRATIGRAPHY: 0.0 - 26.2 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 26.2 - 45.0 FT CRETACEOUS MENEPEE FORMATION (Kmf)
		45														

COMMENTS:

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6488, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE  
SPT= STANDARD PENETRATION TEST FeO= IRON OXIDE MnO= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

CONTROLLED

CONTROLLED

**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

**GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-2**

SHEET 1 OF 1

FEATURE: Pumping Plant 4	PROJECT: Navajo Gallup Water Supply Project	STATE: New Mexico
LOCATION: Site Investigation	COORDINATES: N 1,884,661.2 E 2,464,323.5 N.M. State Plane	GROUND ELEVATION: 5665.5 R. NAD-83
BEGIN: 3/29/16 FINISHED: 3/29/16	TOTAL DEPTH: 45.0	ANGLE FROM HORIZONTAL: -90
DEPTH AND ELEVATION OF WATER LEVEL: NE	DEPTH TO BEDROCK: 13.8	HOLE LOGGED BY: C. Dayer
DATE MEASURED: 3/29/2016		REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILLBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: ONE MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 13.0 FT. 4 1/4" SSA WITH PILOT BIT 13.0 TO 14.5 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS 14.5 TO 45.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT. NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT. NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. PILOT BIT HIT REFUSAL AT 3 FT ON FIRST ATTEMPT. MOVED RIG EAST ABOUT 1 FOOT. PILOT BIT REACHED REFUSAL AT 3 FT AGAIN. MOVED RIG EAST ABOUT 3 FEET AND RESUMED DRILLING.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLING: 13.0 TO 14.5 FT. SPT 18.0 TO 19.0 FT. CALIFORNIA SAMPLE 23.0 TO 24.0 FT. CALIFORNIA SAMPLE 28.0 TO 29.0 FT. CALIFORNIA SAMPLE 33.0 TO 34.0 FT. CALIFORNIA SAMPLE 38.0 TO 39.0 FT. CALIFORNIA SAMPLE 43.0 TO 44.0 FT. CALIFORNIA SAMPLE</p>	0															0.0 TO 13.8 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5																0.0 TO 11.0 FT POORLY GRADED SAND WITH SILT GRAVEL AND COBBLES (SP-SM)gc; ABOUT 50% PREDOMINATELY FINE SAND. TRACE MEDIUM TO COARSE SAND. ABOUT 40% FINE TO COARSE SUBANGULAR, HARD SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH. GRAY IN COLOR; DRY; STRONG REACTION WITH HCl.
	10																TOTAL SAMPLE (BY VOLUME): ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; REMAINDER MINUS 3-INCH; MAXIMUM SIZE, 200mm.
	15																11.0 TO 13.8 FT POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)g; ABOUT 75% PREDOMINATELY FINE SAND. TRACE MEDIUM TO COARSE SAND; ABOUT 15% SUBANGULAR, HARD SANDSTONE; GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; MAXIMUM SIZE, 20mm; DRY, BROWN IN COLOR; STRONG REACTION WITH HCl.
	20																13.8 TO 45.0 FT CRETACEOUS MENEPEE FORMATION (Kmf)
	25																13.8 TO 35.2 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W5), FROM 13.8 TO 14.5 FT. SOFT (H5) AND MODERATELY WEATHERED (W5) FROM 14.5 TO 35.2 FT. GREY IN COLOR, MOTTLED, LAMINATED, CARBONACEOUS FRAGMENT, COAL LAMINATIONS, IRON OXIDE STAINING, THIN CONCRETIONARY INTERBEDS FROM 15.5 TO 16.0 FT AND 18.0 TO 19.1 FT.
	30																35.2 TO 45.0 FT SHALE: SLIGHTLY FISSILE SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (10) TO (11) (H5H6), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING. NO REACTION WITH HCl.
	35																END OF HOLE, TOTAL DEPTH= 45.0
	40																STRATIGRAPHY: 0.0 - 13.8 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 13.8 - 45.0 FT CRETACEOUS MENEPEE FORMATION (Kmf)
	45																

**COMMENTS:**

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK DRAWING NO. 40-D-6489, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE SPT= STANDARD PENETRATION TEST FeO= IRON OXIDE MnO= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

SHEET 1 OF 1 DRILL HOLE DHSTR7-16-2

CONTROLLED

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-3

SHEET 1 OF 1

FEATURE: Pumping Plant 4 PROJECT: Navajo Callup Water Supply Project STATE: New Mexico  
 LOCATION: Site Investigation COORDINATES: N 1,884,899.2 E 2,484,201.7 N.M. State Plane GROUND ELEVATION: 5867.9 R. NAD-83  
 BEGUN: 3/28/16 FINISHED: 3/28/16 TOTAL DEPTH: 45.0 ANGLE FROM HORIZONTAL: -90  
 DEPTH AND ELEVATION OF WATER LEVEL: NE DEPTH TO BEDROCK: 23.5 HOLE LOGGED BY: C. Beyer  
 DATE MEASURED: 3/28/2016 REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILLBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: ONE MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG</p> <p>DRILL METHOD: 0.0 TO 13.0 FT: 4 1/4" SSA WITH PILOT BIT 13.0 TO 22.0 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS 22.0 TO 45.0 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD NONE USED</p> <p>DRILLING MEDIUM 0.0 TO 45.0 NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT; NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. PILOT BIT HIT REFUSAL AT 4 FT ON FIRST ATTEMPT; MOVED RIG EAST ABOUT 3 FEET. PILOT BIT REACHED REFUSAL AT 9 FT AGAIN. MOVED RIG EAST ABOUT 4 FEET AND RESUMED DRILLING.</p> <p>SOLE COMPLETION BACKFILLED WITH BENTONITE</p> <p>SAMPLING: 18.0 TO 19.5 FT: SPT 20.5 TO 22.0 FT: SPT 25.0 TO 26.5 FT: CALIFORNIA SAMPLE 28.0 TO 29.0 FT: CALIFORNIA SAMPLE 30.5 TO 31.5 FT: CALIFORNIA SAMPLE 33.0 TO 34.0 FT: CALIFORNIA SAMPLE 35.5 TO 36.5 FT: CALIFORNIA SAMPLE 38.0 TO 39.0 FT: CALIFORNIA SAMPLE 40.5 TO 41.5 FT: CALIFORNIA SAMPLE 43.0 TO 44.0 FT: CALIFORNIA SAMPLE</p>	0														0.0 TO 23.5 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5		NR													0.0 TO 17.7 FT POORLY GRADED SAND WITH SLT GRAVEL AND COBBLES (SP-SM)gc; ABOUT 50% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND; ABOUT 40% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL; ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; GRAY IN COLOR AND DRY; STRONG REACTION WITH HCl.
	10		Qpd													TOTAL SAMPLE (BY VOLUME): ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINETTE COBBLES; REMAINDER MINUS 3-INCH, MAXIMUM SIZE, 250mm.
	15			32												17.7 TO 23.5 FT POORLY GRADED SAND WITH SLT (SP-SM) ABOUT 90% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL; MAXIMUM SIZE, 75mm; DRY, BROWN IN COLOR; STRONG REACTION WITH HCl.
	20			98				38.6	54.8	6.8	NA	NP	3.2	SM	11/21/26	23.5 TO 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
	25			76		7	8									23.5 TO 33.0 FT CLAYSTONE: VERY SOFT (H7) AND VERY INTENSELY WEATHERED (W8) FROM 23.5 TO 24.0 FT. SOFT (H8) AND MODERATELY WEATHERED (W5) FROM 24.0 TO 33.0 FT. GREY IN COLOR, MOTTLED, LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.
	30							19.3	69.8	10.9	NA	NP	2.2	SM	14/27/30	33.0 TO 35.0 FT SHALE: SLIGHTLY FISSILE SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT TO SOFT (H5-H6), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING, NO REACTION WITH HCl.
	35															35.0 TO 35.9 FT COAL: LIGNITIC, BROWNISH BLACK IN COLOR, SOFT (H8), MODERATELY TO SLIGHTLY WEATHERED (W4), BRITTLE, DULL LUSTER, THINLY BEDDED TO LAMINATED.
	40															35.9 TO 45.0 FT SHALE: SLIGHTLY FISSILE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, IRON OXIDE STAINING, NO REACTION WITH HCl.
	45															END OF HOLE, TOTAL DEPTH=45.0 STRATIGRAPHY: 0.0 - 23.5 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 23.5 - 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)

COMMENTS:  
 THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.  
 HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE  
 SPT= STANDARD PENETRATION TEST FeO= IRON OXIDE MnO= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

CONTROLLED



CONTROLLED

Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-5

SHEET 1 OF 1

FEATURE: Pumping Plant 4 PROJECT: Navajo Gallup Water Supply Project STATE: New Mexico  
 LOCATION: Tank Site COORDINATES: N 1,884,971.0 E 2,484,120.1 N.M. State Plane GROUND ELEVATION: 5867.4 RL NAD 83  
 BEGUN: 3/27/16 FINISHED: 3/27/16 TOTAL DEPTH: 45.0 ANGLE FROM HORIZONTAL: -90  
 DEPTH AND ELEVATION OF WATER LEVEL: NE DEPTH TO BEDROCK: 18.0 HOLE LOGGED BY: P. Gardner, C. Boyer  
 DATE MEASURED: 3/27/2016 REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 3.0 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION		
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT						
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILBREW/ HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CASE MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 13.0 FT: 4 1/4" SSA WITH PILOT BIT 13.0 TO 45.0 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED.</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT: NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT. NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. REACHED REFUSAL AT 4.0 FT ON FIRST ATTEMPT. MOVED 3.0 FT SOUTH AND RESUMED DRILLING.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLING: 20.5 TO 21.5 FT: CALIFORNIA SAMPLE 23.0 TO 24.0 FT: CALIFORNIA SAMPLE 25.5 TO 26.5 FT: CALIFORNIA SAMPLE 28.0 TO 29.0 FT: CALIFORNIA SAMPLE 30.5 TO 31.5 FT: CALIFORNIA SAMPLE 33.0 TO 34.0 FT: CALIFORNIA SAMPLE 35.5 TO 36.5 FT: CALIFORNIA SAMPLE 38.0 TO 39.0 FT: CALIFORNIA SAMPLE 40.5 TO 41.5 FT: CALIFORNIA SAMPLE 43.0 TO 44.0 FT: CALIFORNIA SAMPLE</p>	0.0														SM	0.0 TO 18.0 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)		
	5.0															SP54.9	0.0 TO 2.5 FT SILTY SAND (SM); ABOUT 55% FINE SAND; ABOUT 45% FINES WITH NO PLASTICITY, NO DRY STRENGTH AND SLOW DILATANCY; TRACE GRAVEL, MAXIMUM SIZE, 30mm; BROWN IN COLOR, DRY, STRONG REACTION WITH HCl.	
	10.0															(SP)gc	2.5 TO 18.0 FT POORLY GRADED SAND WITH GRAVEL AND COBBLES (SP)gc; ABOUT 55% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND; ABOUT 40% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL; ABOUT 5% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH; DRY, LIGHT BROWN IN COLOR, STRONG REACTION WITH HCl.	
	15.0			52													SP45.4	TOTAL SAMPLE (BY VOLUME); ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUND SANDSTONE, BASALT AND MINETTE COBBLES; TRACE 5 TO 12 INCH SUBANGULAR TO SUBROUND SANDSTONE, BASALT AND MINETTE COBBLES; REMAINDER MINUS 3 INCH, MAXIMUM SIZE, 200mm.
	20.0			100		7	8										SP45.4	18.0 TO 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
	25.0			100													9/13	18.0 TO 32.5 FT CLAYSTONE: VERY SOFT (#7), AND VERY INTENSELY WEATHERED (#8), FROM 18.0 TO 19.5 FT. SOFT (#6) AND MODERATELY WEATHERED (W5) FROM 18.5 TO 32.5 FT. GREY IN COLOR, MOTTLED, LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING. BECOMES MORE CARBONACEOUS WITH INCREASED COAL LAMINATIONS FROM 29.0 TO 34.0 FT.
	30.0			100		6	5										11/16	
	35.0			100													CLSTNE	32.5 TO 45.0 FT SHALE: SLIGHTLY FISSILE, FRIABLE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (#5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VEINS, AND IRON OXIDE STAINING. NO REACTION WITH HCl.
	40.0			96													2040	END OF HOLE, TOTAL DEPTH=45.0
	45.0			100		5	4										19/28	
				96													4)REFUSAL	STRATIGRAPHY: 0.0 - 18.0 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 18.0 - 45.0 FT CRETACEOUS MENEFFEE FORMATION (Kmf)
																	5834.9	
																	3)REFUSAL	
																	4)REFUSAL	SHALE
																	REFUSAL	
																REFUSAL		
																9822.4		

COMMENTS:  
 THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK DRAWINGS NO. 40-D-6489, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE  
 SP7= STANDARD PENETRATION TEST FeO= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

SHEET 1 OF 1 DRILL HOLE DHSTR7-16-5

CONTROLLED

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-6												SHEET 1 OF 1				
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project			STATE: New Mexico			GROUND ELEVATION: 5871.1 R. NAD-83							
LOCATION: Site Investigation			COORDINATES: N 1,884,780.2 E 2,484,015.5 N.M. State Plane			TOTAL DEPTH: 50.5			ANGLE FROM HORIZONTAL: -90							
BEGIN: 3/23/16 FINISHED: 3/23/16			DEPTH TO BEDROCK: 12.6			HOLE LOGGED BY: C. Beyer			REVIEWED BY: J. Gilbert							
DEPTH AND ELEVATION OF WATER LEVEL: NE																
DATE MEASURED: 3/23/2016																
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILLBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: ONE MODEL 85 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 7.0 FT. 4 1/4" SSA WITH PILOT BIT. 7.0 TO 13.0 FT. 4 1/4" HSA AND DRY CORE SYSTEM. 13.0 TO 50.5 FT. 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 50.5 FT. NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT DEPOSIT. NO SPTS WERE CONDUCTED. VERY DIFFICULT AUGERING THROUGH PEDIMENT DEPOSIT. 50 POUND BAG SAMPLE COLLECTED FROM 0.0 TO 7.0 FT. THE CALIFORNIA SAMPLE TUBE PROVIDED WAS NOT A SPLIT SPOON SAMPLER. BRASS TUBES WERE REMOVED WITH A WOODEN DOWEL AND HAMMER. SAMPLE QUALITY MAY HAVE BEEN COMPROMISED. IN ADDITION, PLASTIC WRAP AND DUCT TAPE USED TO PRESERVE MOISTURE OF SOME SAMPLES. A SPLIT SAMPLE TUBE AND PLASTIC CAPS WERE MAILED OVERNIGHT.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLING: 13.0 TO 14.0 FT. CALIFORNIA SAMPLE 15.5 TO 16.5 FT. CALIFORNIA SAMPLE 18.0 TO 19.0 FT. CALIFORNIA SAMPLE 20.5 TO 21.5 FT. CALIFORNIA SAMPLE 23.0 TO 24.0 FT. CALIFORNIA SAMPLE 25.5 TO 26.5 FT. CALIFORNIA SAMPLE 28.0 TO 29.0 FT. CALIFORNIA SAMPLE 30.5 TO 31.5 FT. CALIFORNIA SAMPLE 33.0 TO 34.0 FT. CALIFORNIA SAMPLE 35.5 TO 36.5 FT. CALIFORNIA SAMPLE 38.0 TO 39.0 FT. CALIFORNIA SAMPLE 40.5 TO 41.5 FT. CALIFORNIA SAMPLE 43.0 TO 44.0 FT. CALIFORNIA SAMPLE 45.0 TO 46.0 FT. CALIFORNIA SAMPLE 48.0 TO 49.0 FT. CALIFORNIA SAMPLE (NO RECOVERY)</p>	0														0.0 TO 12.6 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5	PILOT														0.0 TO 12.6 FT POORLY GRADED GRAVEL WITH SAND AND COBBLES (GP)nc. ABOUT 60% PREDOMINATELY FINE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL. TRACE COARSE GRAVEL. ABOUT 30% PREDOMINATELY FINE SAND. TRACE MEDIUM TO COARSE SAND. ABOUT 1% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH.
	10															TOTAL SAMPLE (BY VOLUME): ABOUT 10% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUNDED SANDSTONE, BASALT AND MINOR COBBLES. REMAINDER MINUS 3-INCH MAXIMUM SIZE, 125mm.
	15	PILOT														12.6 TO 50.5 FT CRETACEOUS MENEPEE FORMATION (Kmf)
	19															12.6 TO 35.0 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W8), FROM 12.6 TO 13.2 FT. SOFT (H8) AND MODERATELY WEATHERED (W5) FROM 13.2 TO 35.0 FT. GREY IN COLOR, MOTTLED, THINLY BEDDED TO LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.
	20															35.0 TO 37.5 FT SHALE: SLIGHTLY FISSILE, FRAGILE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VEINS, AND IRON OXIDE STAINING. NO REACTION WITH HCl.
	25															37.5 TO 41.7 FT COAL: LIGNITIC, BROWNISH BLACK IN COLOR, SOFT (H8), MODERATELY TO SLIGHTLY WEATHERED (W4), BRITTLE, DULL LUSTER, THINLY BEDDED TO LAMINATED, NO REACTION WITH HCl.
	30															41.7 TO 50.5 FT SHALE: SLIGHTLY FISSILE, FRAGILE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VEINS, AND IRON OXIDE STAINING. NO REACTION WITH HCl.
	35															JOB MEASUREMENTS DEPTH INCL R M T HL INFILLING 41.7 48.8 90 5 2 3 5 IRON OXIDE
	40															END OF HOLE, TOTAL DEPTH= 50.5
	45															STRATIGRAPHY: 0.0 - 12.6 FT. QUATERNARY PEDIMENT DEPOSIT (Qpd) 12.6 - 50.5 FT. CRETACEOUS MENEPEE FORMATION (Kmf)
	50															
	BOTTOM OF HOLE															
	<p>COMMENTS:</p> <p>THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK DRAWING NO. 40-D-6489, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.</p> <p>HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTONE= CLAYSTONE SPT= STANDARD PENETRATION TEST FeO= IRON OXIDE MnO= MANGANESE OXIDE HCl= HYDROCHLORIC ACID</p>															
													SHEET 1 OF 1		DRILL HOLE DHSTR7-16-6	

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-7

SHEET 1 OF 1

FEATURE: Pumping Plant 4 PROJECT: Navajo Gallup Water Supply Project STATE: New Mexico  
 LOCATION: Site Investigation COORDINATES: N 1,884,652.7 E 2,484,095.3 N.M. State Plane GROUND ELEVATION: 5868.1 ft. NAD-83  
 BEGUN: 3/28/16 FINISHED: 3/28/16 TOTAL DEPTH: 45.0 ANGLE FROM HORIZONTAL: -90  
 DEPTH AND ELEVATION OF WATER LEVEL: NE DEPTH TO BEDROCK: 20.1 HOLE LOGGED BY: C. Boyer  
 DATE MEASURED: 3/28/2016 REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION					
<p>ALL MEASUREMENTS ARE FROM GROUND LEVEL AND ARE THE SAME AS THOSE USED BY DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: UPPER COLORADO DRILL CREW DRILLER: KYLE KILBREW HELPER: JOE PROCTOR HELPER: RENATO MATHESON</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: ONE MODEL 95 TRUCK MOUNTED ROTARY DRILL RIG.</p> <p>DRILL METHOD: 0.0 TO 13.0 FT: 4 1/4" SSA WITH PILOT BIT. 13.0 TO 20.5 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH SPTS. 20.5 TO 45.0 FT: 4 1/4" HSA AND DRY CORE SYSTEM WITH CALIFORNIA SAMPLER.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 TO 45.0 FT: NONE</p> <p>DRILLING NOTES: PILOT BIT USED TO PENETRATE PEDIMENT GRAVEL DEPOSIT; NO SPTS WERE CONDUCTED IN GRAVEL. VERY DIFFICULT AUGERING THROUGH PEDIMENT GRAVEL. REACHED REFUSAL AT 2.0 FT ON FIRST ATTEMPT, MOVED ABOUT 4 FEET NORTHEAST AND RESUMED DRILLING.</p> <p>HOLE COMPLETION: BACKFILLED WITH BENTONITE.</p> <p>SAMPLES: 13.0 TO 14.5 FT: SPT 15.5 TO 17.0 FT: SPT 18.0 TO 19.5 FT: SPT 20.5 TO 21.5 FT: CALIFORNIA SAMPLE 23.0 TO 24.0 FT: CALIFORNIA SAMPLE 28.0 TO 29.0 FT: CALIFORNIA SAMPLE 33.0 TO 34.0 FT: CALIFORNIA SAMPLE 38.0 TO 39.0 FT: CALIFORNIA SAMPLE 43.0 TO 44.0 FT: CALIFORNIA SAMPLE</p>	0.0															0.0 TO 20.1 FT QUATERNARY PEDIMENT DEPOSIT (Qpd)		
	5		PILOT														0.0 TO 10.0 FT POORLY GRADED SAND WITH SILT AND GRAVEL, COBBLES AND BOULDERS (SP-SM)gcb; ABOUT 50% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 40% FINE TO COARSE SUBANGULAR, HARD, SANDSTONE, CHERT AND PETRIFIED WOOD GRAVEL, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH, DRY, GRAY IN COLOR, STRONG REACTION WITH HCl	
	10		Qpd														TOTAL SAMPLE (BY VOLUME): ABOUT 5% 3 TO 5 INCH HARD, SUBANGULAR TO SUBROUND SANDSTONE, BASALT AND MINETTE COBBLES, ABOUT 5% TO 12 INCH HARD, SUBANGULAR TO SUBROUND SANDSTONE, BASALT AND MINETTE COBBLES, TRACE HARD, SUBANGULAR SANDSTONE BOULDERS, REMAINDER MINUS 3-INCH MAXIMUM SIZE, 450mm.	
	15			100				46.6	53.4	0.0	NA	NP	2.7	SM	10/17/20		(SP-SM)gcb	10.0 TO 15.0 FT POORLY GRADED SAND WITH SILT (SP-SM) ABOUT 90% PREDOMINATELY FINE SAND, TRACE MEDIUM TO COARSE SAND, ABOUT 10% NONPLASTIC FINES WITH RAPID DILATANCY AND NO DRY STRENGTH, TRACE SUBANGULAR, HARD, SANDSTONE GRAVEL, MAXIMUM SIZE: 20mm; DRY, BROWN IN COLOR, STRONG REACTION WITH HCl.
	20			100				66.2	33.1	0.7	22.0	6.1	3.4	CL-MI	20/32/29		SC	15.0 TO 20.1 FT CLAYEY SAND (SC) ABOUT 80% PREDOMINATELY FINE SAND, ABOUT 20% FINES WITH LOW PLASTICITY, LOW DRY STRENGTH AND LOW TOUGHNESS, TRACE MEDIUM TO COARSE SAND, GRAY IN COLOR, DRY, STRONG REACTION WITH HCl.
	25			100				72.1	27.9	0.0	20.4	1.8	3.6	(ML)s	15/29/34		9920	20.1 TO 45.0 FT CRETACEOUS MENEPEE FORMATION (Kmf)
	30			100		7	8											20.1 TO 35.0 FT CLAYSTONE: VERY SOFT (H7), AND VERY INTENSELY WEATHERED (W9). FROM 20.1 TO 20.6 FT, SOFT (H6) AND MODERATELY WEATHERED (W5) FROM 20.6 TO 35.0 FT, GREY IN COLOR, MOTTLED, THINLY BEDDED TO LAMINATED, CARBONACEOUS FRAGMENTS, COAL LAMINATIONS, GYPSUM NODULES, AND IRON OXIDE STAINING.
	35			100			6	5										35.0 TO 45.0 FT SHALE: SLIGHTLY FISSILE, FRAGILE, SLIGHTLY TO MODERATELY WEATHERED (W4) MODERATELY SOFT (H5), CARBONACEOUS, LAMINATED TO THINLY BEDDED, COAL LAMINATIONS, BROWN TO BLACK IN COLOR, GYPSUM VEINS, AND IRON OXIDE STAINING, NO REACTION WITH HCl.
	40			100			5	4										END OF HOLE, TOTAL DEPTH= 45.0
	45			100														STRATIGRAPHY: 0.0 - 20.1 FT QUATERNARY PEDIMENT DEPOSIT (Qpd) 20.1 - 45.0 FT CRETACEOUS MENEPEE FORMATION (Kmf)
																		SHALE
																		REFUSAL
																		9924.1
																		BOTTOM OF HOLE

COMMENTS:

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK DRAWING NO. 40-D-6489, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES. ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

HSA= HOLLOW STEM AUGER SSA= SOLID STEM AUGER NE= NOT ENCOUNTERED NA= NOT AVAILABLE NP= NON PLASTIC SS= SANDSTONE CLSTNE= CLAYSTONE SPT= STANDARD PENETRATION TEST FeOx= IRON OXIDE MnOx= MANGANESE OXIDE HCl= HYDROCHLORIC ACID

SHEET 1 OF 1 DRILL HOLE DHSTR7-16-7

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-8														SHEET 1 OF 1		
FEATURE: Pumping Plant 4 LOCATION: Site Investigation BEGUN: 9/2/16 FINISHED: 9/2/16 DEPTH AND ELEVATION OF WATER LEVEL: NE DATE MEASURED: 9/2/2016			PROJECT: Navajo Gallup Water Supply Project COORDINATES: N 1,885,079.2 E 2,484,339.0 N.M. State Plane TOTAL DEPTH: 215 DEPTH TO BEDROCK: 20.2					STATE: New Mexico GROUND ELEVATION: 5862.6 ft. NAD-83 ANGLE FROM HORIZONTAL: -90 HOLE LOGGED BY: P. Gardner REVIEWED BY: J. Gilbert								
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 20.0: 4.25 inch HSA with pilot bit 20.0 to 21.5: 4.25 inch HSA with SPT</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 21.5: None</p> <p>DRILLING NOTES: 0.0 to 20.0: Difficult with pilot bit to 14.8 20.0 to 21.5: SPT</p> <p>HOLE COMPLETION: Backfilled with bentonite and outtings.</p> <p>SAMPLES: 20.0 to 21.5: SPT</p>	5														<p><b>0.0 to 20.2 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)</b></p> <p>0.0 to 14.8 ft. COBBLES AND BOULDERS WITH SILTY GRAVEL AND SAND: Visual classification from test pit 50 feet to the south of drill hole with about 80% 3 to 5 inch hard, subrounded to subangular cobbles, about 20% 5 to 12 inch hard, subangular to subrounded cobbles, about 15% hard, subrounded boulders, remainder minus 3 inch, maximum size, 1000mm. Bottom of interval determined by drill action.</p> <p>MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel, about 30% fine to medium, subrounded sand; about 20% nonplastic fines; no reaction with HCl.</p> <p>0.0 to 20.0 ft Pilot Bit: Recovered outtings as silt and sand with hard, subangular to angular gravels. Strong reaction with HCl.</p> <p>20.0 to 20.2 ft SILTY SAND WITH GRAVEL (SM): About 70% fine to coarse, hard sand; about 15% fine, hard, subangular to angular gravels, about 15% nonplastic fines; light brown and dry, strong reaction with HCl.</p> <p><b>20.2 to 21.5 ft CRETACEOUS MENEFEE FORMATION (Kmf)</b></p> <p>20.2 to 21.5 ft CLAYSTONE: Brownish gray and orange in color. Soft (H6) and very intensely weathered (W5). FeOx staining present.</p> <p><b>STRATIGRAPHY:</b> 0.0 to 20.2 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 20.2 to 21.5 ft CRETACEOUS MENEFEE FORMATION (Kmf)</p>	
	10	Qpd	NR													<p>Cobbles and Boulders</p>
	20															<p>5942.4</p>
		Kmf	83	NA	6	8	55.8	40.4	3.8	31.0	20.3	9.0	9(CL)	8/17/15	CLSTNE	5941.1
BOTTOM OF HOLE																
<p><b>COMMENTS:</b></p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HC3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-10												SHEET 1 OF 1				
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project			STATE: New Mexico			GROUND ELEVATION: 5865.2 ft. NAD-83							
LOCATION: Tank Sills			COORDINATES: N 1,885,048.8 E 2,464,169.7 N.M. State Plane			ANGLE FROM HORIZONTAL: -90			HOLE LOGGED BY: P. Garner							
BEGIN: 8/1/16 FINISHED: 8/1/16			TOTAL DEPTH: 25.5			DEPTH TO BEDROCK: 24.1			REVIEWED BY: J. Gilbert							
DEPTH AND ELEVATION OF WATER LEVEL: NE																
DATE MEASURED: 8/1/2016																
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWBLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rieratty HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 17.5: 4.25 inch HSA with pilot bit 17.5 to 25.5: 4.25 inch HSA dry core system with SPT.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 25.5: None</p> <p>DRILLING NOTES: 0.0 to 17.5: Difficult with pilot bit 17.5 to 25.5: Dry core with SPT.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLING: 19.0 to 20.5: SPT 24.0 to 25.5: SPT</p>	5														0.0 to 24.1 ft QUATERNARY PEDIMENT DEPOSIT (Qpc)	
	10														0.0 to 17.5 ft COBBLES AND BOULDERS WITH SILTY SAND WITH GRAVEL. Visual classification from test pit 130 feet to the west of drill hole with about 85% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 5% hard, subrounded boulders; remainder minus 3 inch; maximum size, 700mm. Bottom of interval determined by drill action.	
	15														MINUS 3 inch FRACTION (BY MASS): About 50% fine to medium, subrounded sand; about 30% hard, subrounded gravel; about 20% nonplastic fines; no reaction with HCl.	
	20														0.0 to 17.5 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.	
	20														17.5 to 24.1 ft POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)g: About 70% fine to coarse, hard sand; about 20% fine, hard, subangular to angular gravel; about 10% nonplastic fines; light brown to gray and cry; strong reaction with HCl.	
	25														24.1 to 25.5 ft CRETACEOUS MENEFEE FORMATION (Kmf)	
	25														24.1 to 25.5 ft CLAYSTONE: Brownish gray and tan to orange in color. Soft (HS) and very intensely weathered (WS). FeOx staining present.	
	25														STRATIGRAPHY: 0.0 to 24.1 ft QUATERNARY PEDIMENT DEPOSIT (Qpc) 24.1 to 25.5 ft CRETACEOUS MENEFEE FORMATION (Kmf)	
	25	Kmf	100		6	8	96.3	21.5	3.7	55.8	44.2	17.6	CH	8/16/21	CLSTNE 9838.7	
BOTTOM OF HOLE																
<p>COMMENTS:</p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQS= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-11													SHEET 1 OF 1			
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Site Investigation			COORDINATES: N 1,885,093.8 E 2,484,076.3 N.M. State Plane				GROUND ELEVATION: 5864.9 ft. NAD83									
BEGUN: 8/2/16 FINISHED: 8/2/16			TOTAL DEPTH: 20.0				ANGLE FROM HORIZONTAL: -90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 16.5				HOLE LOGGED BY: P. Gartner									
DATE MEASURED: 8/2/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>All measurements are from ground level and are the same as those used by dilers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Bob Simmons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 15.0: 4.25 inch HSA with pilot bit. 15.0 to 20.0: 4.25 inch HSA and dry core system with California Sampler.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 20.0: None</p> <p>DRILLING NOTES: 0.0 to 13.1: Difficult with pilot bit. 13.1 to 15.0: Drilling became easy. 15.0 to 20.0: HSA with California Sampler.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLING: 19.0 to 20.0: California Sample</p>															<p><b>0.0 to 16.8 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)</b></p> <p>0.0 to 13.1 ft COBBLES AND Boulders WITH SILTY SAND AND GRAVEL: Visual classification from test pit 175 feet to the south of drill hole with about 65% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 3 to 12 inch hard, subangular to subrounded cobbles; about 5% hard, subrounded boulders; remainder minus 3 inch, maximum size, 70mm. Bottom of interval determined by drill action.</p> <p>MINUS 3 inch FRACTION (BY MASS): About 50% fine to medium, subrounded sand; about 30% hard, subrounded gravel; about 20% nonplastic fines, no reaction with HCl.</p> <p>0.0 to 15.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravels. Strong reaction with HCl</p> <p>15.0 to 16.8 ft SILTY SAND WITH GRAVEL (SM)g: About 70% fine sand; about 15% fine, hard, subrounded to subangular gravel; about 15% nonplastic fines, maximum size, 20mm; light brown and dry; strong reaction with HCl.</p>	
		Qpd														<p><b>16.8 to 20.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)</b></p> <p>16.8 to 20.0 ft CLAYSTONE: Brownish gray in color. Soft (HS) and very intensely weathered (WS). FeOx staining present.</p> <p><b>STRATIGRAPHY:</b> 0.0 to 16.8 ft QUATERNARY PEDIMENT (Qpd) 16.8 to 20.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)</p>
	15															<p>5840.9</p> <p>(SM)g</p> <p>5840.1</p> <p>CLSTNE</p> <p>14/22</p> <p>5844.9</p>
	83															
	6															
	8															
	NA															
	20															
BOTTOM OF HOLE																
<p><b>COMMENTS:</b></p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQD= casing system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																

SHEET 1 OF 1 DRILL HOLE DHSTR7-16-11

65

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-12														SHEET 1 OF 1		
FEATURE: Pumping Plant 4 LOCATION: Site Investigation BEGUN: 8/4/16 FINISHED: 8/4/16 DEPTH AND ELEVATION OF WATER LEVEL: NE DATE MEASURED: 8/4/2016			PROJECT: Navajo Gallup Water Supply Project COORDINATES: N 1,884,804.2 E 2,484,255.7 N.M. State Plane TOTAL DEPTH: 35.0 DEPTH TO BEDROCK: 15.3				STATE: New Mexico GROUND ELEVATION: 5885.5 ft. NAD-83 ANGLE FROM HORIZONTAL: -90 HOLE LOGGED BY: P. Gardner REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew <b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> ONE Model 85 truck mounted rotary drill rig</p> <p><b>DRILL METHOD:</b> 0.0 to 15.0: 4.25 inch HSA with pilot bit. 15.0 to 31.8: 4.25 inch HSA and dry core system with SPT and California Sampler. 31.8 to 35.0: 4.25 inch HSA with pilot bit.</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 35.0: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 15.0: Difficult with pilot bit, easy at 12.0. 15.0 to 31.8: HSA with SPT and California Sampler to refusal. 31.8 to 35.0: HSA with pilot bit, very difficult and slow. No recovery.</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLING:</b> 15.0 to 16.5: SPT 19.0 to 20.0: California Sample 24.0 to 25.5: SPT 29.0 to 30.0: California Sample</p>	0.0														0.0 to 15.3 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5															0.0 to 12.8 ft COBBLES AND BouldERS WITH SILTY SAND. Visual classification from test pit 175 feet to the northeast of drill hole with about 80% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders; remainder minus 3 inch; maximum size, 900mm. Bottom of interval determined by drill action.
	10	Qpd														MINUS 3 inch FRACTION (BY MASS). About 80% fine sand; about 20% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.
	15															0.0 to 15.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
	15.3															15.0 to 15.3 ft SILTY SAND WITH GRAVEL (SMG). About 65% fine to coarse, hard sand; about 20% fine, hard, subrounded to angular gravel; about 15% nonplastic fines, maximum size, 20mm; light brown and dry; strong reaction with HCl.
	15.3															15.3 to 35.0 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
	15.3															15.3 to 31.8 ft CLAYSTONE: Gray to orange in color. Very soft (H7) and intensely weathered (W7). Carbonaceous, friable and easily scratched with thumbnail. CaCO <sub>3</sub> , gypsum and FeOx staining present. No reaction with HCl.
	20															31.8 to 35.0 ft SANDSTONE: Gray in color and fine grained. Hard (H3) and difficult to scratch with pick. Slightly weathered (W3). Carbonaceous blebs present. No reaction with HCl.
	25															STRATIGRAPHY: 0.0 to 15.3 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 15.3 to 35.0 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
	25															CLSTNE
25															99.0 1.0 0.0 73.0 49.9 18.2 CH 9/16/31	
30															31/50	
30															983.7	
35															SS	
															983.5	
															BOTTOM OF HOLE	

**COMMENTS:**

HSA=hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO<sub>3</sub>= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6488 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-13

SHEET 1 OF 1

FEATURE: Pumping Plant 4 PROJECT: Navajo Gallup Water Supply Project STATE: New Mexico  
 LOCATION: Surge Tank COORDINATES: N 1,894,688.3 E 2,464,248.2 N.M. State Plane GROUND ELEVATION: 5857.2 ft. NAD-83  
 BEGIN: 7/31/16 FINISHED: 7/31/16 TOTAL DEPTH: 35.0 ANGLE FROM HORIZONTAL: 90  
 DEPTH AND ELEVATION OF WATER LEVEL: NE DEPTH TO BEDROCK: 15.4 HOLE LOGGED BY: P. Gardner, C. Bayor  
 DATE MEASURED: 7/31/2016 REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 15.0: 4.25 inch HSA with pilot bit. 15.0 to 35.0: 4.25 inch HSA dry core system with SPT and California Sampler.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 35.0: None</p> <p>DRILLING NOTES: 0.0 to 15.0: HSA with pilot bit, very slow. Easy at 12.0. 15.0 to 35.0: HSA and sampling</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLING 15.0 to 16.5: SPT (15.4 to 16.5 sent to lab) 20.0 to 21.0: California Sample 25.0 to 26.5: SPT 30.0 to 31.0: California Sample 33.5 to 35.0: SPT</p>	0.0														0.0 to 15.4 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5														0.0 to 12.0 ft COBBLES AND BOULDERS WITH SILTY SAND: Visual classification from test pit 20 feet to the northeast of drill hole with about 60% 3 to 5 inch hard, subrounded to subangular cobbles, about 20% 5 to 12 inch hard, subangular to subrounded cobbles, about 15% hard, subrounded boulders, remainder minus 3 inch; maximum size, 900 mm. Bottom of interval determined by drill action.	
	10	Qpd													MINUS 3 inch FRACTION (BY MASS): About 80% fine sand; about 20% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.	
	15														0.0 to 15.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.	
	18													18/27/31	15.0 to 15.4 ft POORLY GRADED SAND (SP SM): About 90% fine to coarse, hard sand; about 10% nonplastic fines; trace of gravel; maximum size, 50 mm; strong reaction with HCl.	
	20			40											15/30	15.4 to 35.0 ft CRETACEOUS MENEPEE FORMATION (Kmf)
	25					6	8									15.4 to 33.2 ft CLAYSTONE: Brownish gray, dark gray and tan to orange in color. Soft (H6) and very intensely weathered (W8). Carbon fragments, CaCO <sub>3</sub> and FeOx staining present. Joint at 29.3 ft.
	25	Kmf						93.2	6.8	0.0	44.2	27.1	10.3	CL		JOINT MEASUREMENTS: DEPTH INCL R T HL INFILLING 29.3 80 5 1 6 FeOx
	30															33.2 to 35.0 ft SHALE: Dark gray in color. Friable, friable, slightly to moderately weathered (W4) and moderately soft (H5). Laminated to thinly bedded with FeOx staining and CaCO <sub>3</sub> present. No reaction with HCl.
	35			80		5	4									STRATIGRAPHY: 0.0 to 15.4 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 15.4 to 35.0 ft CRETACEOUS MENEPEE FORMATION (Kmf)
							99.3	0.7	0.0	56.5	38.2	13.1	CH	32/50/NA	SHALE 9832.2	
							BOTTOM OF HOLE									

COMMENTS:  
 HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO<sub>3</sub>= calcium carbonate  
 MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTONE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6496 Standard Descriptors and Descriptive Criteria for Discontinuities.

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-15

SHEET 1 OF 1

FEATURE: Pumping Plant 4	PROJECT: Navajo Gallup Water Supply Project	STATE: New Mexico
LOCATION: Pumping Plant	COORDINATES: N 1,894,856.2 E 2,464,265.8 N.M. State Plane	GROUND ELEVATION: 5687.3 ft. NAD-83
BEGIN: 8/2/16 FINISHED: 8/3/16	TOTAL DEPTH: 34.0	ANGLE FROM HORIZONTAL: -90
DEPTH AND ELEVATION OF WATER LEVEL: NE	DEPTH TO BEDROCK: 31.5	HOLE LOGGED BY: P. Gardner
DATE MEASURED: 8/3/2016		REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 20.0: 4.25 inch HSA with pilot bit 20.0 to 34.0: 4.25 inch HSA and dry core system.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 34.0: None</p> <p>DRILLING NOTES: 0.0 to 20.0: Difficult with pilot bit. 20.0 to 34.0: Poor recovery.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings</p> <p>SAMPLES: No sampling performed</p>															0.0 to 31.5 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)	
																0.0 to 15.8 ft. COBBLES AND BOULDERS WITH SILTY GRAVEL AND SAND. Visual classification from test pit 150 feet to the south of drill hole with about 50% 3 to 5 inch hard, subrounded to subangular cobbles; about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders; remainder minus 3 inch, maximum size, 1000mm. Bottom of interval determined by drill action.
																MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel; about 30% fine to medium, subrounded sand; about 20% nonplastic fines; no reaction with HCl.
																0.0 to 20.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
																20.0 to 24.0 ft SILTY SAND WITH GRAVEL (SM)g: About 65% fine to coarse, hard sand; about 15% fine, hard, subangular to angular gravel; about 20% nonplastic fines; light brown and dry, strong reaction with HCl.
																24.0 to 31.5 ft Poor Recovery: Materials recovered were approx. 65% fine to coarse, hard sand; approx. 25% fine to coarse, hard, subangular to angular gravel; approx. 10% nonplastic fines; maximum size, 75mm; light brown and dry, strong reaction with HCl.
																31.5 to 34.0 ft CRETACEOUS MENEPEE FORMATION (Kmf)
																31.5 to 34.0 ft CLAYSTONE: Brownish gray and tan to orange in color. Soft (H6) and very intensely weathered (W5). FeOx staining present.
																STRATIGRAPHY: 0.0 to 31.5 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 31.5 to 34.0 ft CRETACEOUS MENEPEE FORMATION (Kmf)
																5947.3
															5943.3	31.5 to 34.0 ft CRETACEOUS MENEPEE FORMATION (Kmf)
															5938.9	
															5933.3	CLSTNE
																BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities.

SHEET 1 OF 1 DRILL HOLE DHSTR7-16-15

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-16													SHEET 1 OF 1			
FEATURE: Pumping Plant 4			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Pumping Plant			COORDINATES: N 1,884,854.7 E 2,484,222.3 N.M. State Plane				GROUND ELEVATION: 5867.9 ft. NAD-83									
BEGIN: 8/1/16 FINISHED: 8/1/16			TOTAL DEPTH: 29.0				ANGLE FROM HORIZONTAL: -90									
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 26.3				HOLE LOGGED BY: P. Garner									
DATE MEASURED: 8/1/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew <b>DRILLER:</b> Sean Rafferty <b>HELPER:</b> Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> CME Model 85 truck mounted rotary drill rig</p> <p><b>DRILL METHOD:</b> 0.0 to 15.0: 4.25 inch HSA with pilot bit. 15.0 to 28.0: 4.25 inch HSA and dry core system.</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 29.0: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 14.0: Difficult with pilot bit 14.0 to 29.0: Gravels through 21.0 to 22.5 and at 25.0.</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLING:</b> No sampling performed.</p>	0														0.0 to 26.3 ft QUATERNARY PEDIMENT DEPOSIT (Qpd)	
	5															0.0 to 14.0 ft COBBLES AND BOULDERS WITH SILTY GRAVEL AND SAND: Visual classification from test pit 150 feet to the south of drill hole with about 50% 3 to 5 inch hard, subrounded to subangular cobbles, about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders, remainder minus 3 inch maximum size, 100um. Bottom of interval determined by drill action.
	10															MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel; about 30% fine to medium, subrounded sand; about 20% nonplastic fines, no reaction with HCl.
	15	Qpd														0.0 to 15.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
	20															15.0 to 19.0 ft No Recovery: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
	25															19.0 to 26.3 ft POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)g: About 70% fine to coarse hard sand; about 20% fine, hard, subangular to angular gravel; about 10% nonplastic fines; light to dark brown, dry, FeOx staining present, strong reaction with HCl.
	26.3															26.3 to 29.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
	28.0															26.3 to 29.0 ft CLAYSTONE: Brownish gray and tan in color. Soft (HS) and very intensely weathered (WB). FeOx staining present.
	29.0															STRATIGRAPHY: 0.0 to 26.3 ft QUATERNARY PEDIMENT DEPOSIT (Qpd) 26.3 to 29.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
																5839.9
															5843.9	(SP-SM)g
															5841.6	
															5839.9	CLSTNE
																BOTTOM OF HOLE

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

GEOLOGIC LOG OF DRILL HOLE NO. DHSTR7-16-18												SHEET 1 OF 1				
FEATURE: Pumping Plant 4 LOCATION: Pumping Plant BEGUN: 9/3/16 FINISHED: 9/3/16 DEPTH AND ELEVATION OF WATER LEVEL: NE DATE MEASURED: 9/3/2016			PROJECT: Navajo Gallep Water Supply Project COORDINATES: N 1,884,722.1 E 2,464,225.3 N.M. State Plane TOTAL DEPTH: 29.0 DEPTH TO BEDROCK: 23.8				STATE: New Mexico GROUND ELEVATION: 5867.5 ft. NAD-83 ANGLE FROM HORIZONTAL: -90 HOLE LOGGED BY: P. Connor REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RSD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p><b>DRILLED BY:</b> Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Bob Sammons</p> <p><b>PURPOSE:</b> Preconstruction soil and bedrock foundation investigations.</p> <p><b>DRILL EQUIPMENT:</b> ONE Model 65 truck mounted rotary drill rig</p> <p><b>DRILL METHOD:</b> 0.0 to 20.0: 4.25 inch HSA with pilot bit, 20.0 to 28.0: 4.25 inch HSA and dry core system.</p> <p><b>CASING RECORD:</b> None used</p> <p><b>DRILLING MEDIUM:</b> 0.0 to 29.0: None</p> <p><b>DRILLING NOTES:</b> 0.0 to 20.0: Difficult with pilot bit, easy at 16.0. 20.0 to 28.0: Poor recovery.</p> <p><b>HOLE COMPLETION:</b> Backfilled with bentonite and cuttings.</p> <p><b>SAMPLING:</b> No sampling performed.</p>	0														0.0 to 23.8 ft QUATERNARY PEDIMENT DEPOSIT (Qpc)	
	5															0.0 to 16.0 ft COBBLES AND BOULDERS WITH SILTY GRAVEL AND SAND: Visual classification from test pit 75 feet to the north east of drill hole with about 60% 3 to 9 inch hard, subrounded to subangular cobbles, about 20% 5 to 12 inch hard, subangular to subrounded cobbles; about 15% hard, subrounded boulders, remainder minus 3 inch, maximum size, 1000mm. Bottom of interval determined by drill action.
	10															MINUS 3 inch FRACTION (BY MASS): About 50% hard, subrounded gravel; about 30% fine to medium, subrounded sand; about 20% nonplastic fines; no reaction with HCl.
	15															0.0 to 20.0 ft Pilot Bit: Recovered cuttings as silt and sand with hard, subangular to angular gravel. Strong reaction with HCl.
	20		8													20.0 to 23.8 ft Poor Recovery: Materials recovered were approx. 75% fine to coarse, hard sand; approx. 20% nonplastic fines; approx. 5% fine, hard, subangular to angular gravel; maximum size, 20mm; light brown and dry, strong reaction with HCl.
	25															23.8 to 28.0 ft CRETACEOUS MENEFE FORMATION (Kmf)
																23.8 to 29.0 ft CLAYSTONE: Gray and orange in color. Soft (HS) and very intensely weathered (WS). FeOx staining and CaCO3 with gypsum present. Some carbonaceous fragments present.
																STRATIGRAPHY: 0.0 to 23.8 ft QUATERNARY PEDIMENT DEPOSIT (Qpc) 23.8 to 29.0 ft CRETACEOUS MENEFE FORMATION (Kmf)
																9851.5
																9843.7
																9838.5
																CLSTNE
BOTTOM OF HOLE																
<p><b>COMMENTS:</b></p> <p>HSA=hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

## **Appendix F – Test Pit Logs**

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**Technical Memorandum No. ZN-8314-5**  
**Pumping Plant 4 – Geotechnical Design**

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-1</b>	SHEET 1 OF 1		
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT			
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5866.7			
COORDINATES: N 1,864,951 E 2,464,253		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE			
APPROXIMATE DIMENSIONS: 5'X12'X9'		LOGGED BY: J. GILBERT			
DEPTH TO WATER: NE DATE: 8/1/2016		DATE EXCAVATED: 8/1/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	COBBLES AND BOULDERS	<p>0.0 to 9.0 ft COBBLES AND BOULDERS WITH SILTY SAND WITH GRAVELS: TOTAL SAMPLE (BY VOLUME): About 60% 3- to 5-inch hard subrounded to subangular cobbles; about 10% 5- to 12-inch hard, subangular to subrounded cobbles; about 10% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 700 mm.</p> <p>MINUS 3-inch FRACTION (BY MASS): About 50% fine to medium subrounded sand; about 30% hard subrounded gravel; about 20% nonplastic fines; no reaction with HCl.</p> <p>IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.</p> <p>GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)</p>	60	10	10
2					
3					
4					
5					
6					
7					
8					
9					
<p>COMMENTS: Surface vegetation consists of grasses, weeds and brush. Discontinued hole due to limit of equipment. Corrosion sample taken at 8.5 feet.</p> <p>NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid</p>					

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**Technical Memorandum No. ZN-8314-5**  
**Pumping Plant 4 – Geotechnical Design**

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-2</b>		SHEET 1 OF 1		
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT				
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5867.3				
COORDINATES: N 18,849,191 E 2,464,104		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE				
APPROXIMATE DIMENSIONS: 7'X12'X10.5'		LOGGED BY: J. GILBERT				
DEPTH TO WATER: NE DATE: 8/1/2016		DATE EXCAVATED: 8/1/2016				
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)			
			3 - 5 in	5 - 12 in	PLUS 12 in	
1	SM (visual) (SM)g (lab classification)	0.0 to 2.7 ft SILTY SAND: About 80% fine sand; about 20% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; weak reaction with HCl.				
2	In-place Density taken at 1.8 ft	IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous.				
3	2.7 ft (5864.6)	IN-PLACE UNIT WEIGHT AND MOISTURE FROM 1.8 TO 2.5 ft. Total: 95.4 lbs. / cu ft., 2.9%. (78.3% compaction) LAB TEST DATA: 61.5% sand, 22.7% fines, 15.8% gravel, LL= NA, PI= NP, SPG= 2.57 Maximum dry density= 121.9 lbs. / cu ft., optimum water content= 11.0% Laboratory classification is: SILTY SAND WITH GRAVEL	65	20	5	
4	COBBLES AND BOULDERS	GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd) 2.7 to 10.5 ft: COBBLES AND BOULDERS WITH SILTY SAND WITH GRAVEL : TOTAL SAMPLE (BY VOLUME): About 65% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 5% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 700 mm.				
5		MINUS 3-inch FRACTION (BY MASS): About 50% fine to medium subrounded sand; about 30% hard subrounded gravel; about 20% nonplastic fines; no reaction with HCl.				
6		IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.				
7		GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)				
8						
9						
10						
	10.5 ft (5856.8)					
COMMENTS: Discontinued hole due to limit of equipment. In-place density taken at 1.8 feet. NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid						

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPSTR7-16-3		SHEET 1 OF 1		
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT				
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5869.2				
COORDINATES: N 1,884,912 E 2,464,109		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE				
APPROXIMATE DIMENSIONS: 6'X11'X11.1'		LOGGED BY: J. GILBERT				
DEPTH TO WATER: NE DATE: 8/1/2016		DATE EXCAVATED: 8/1/2016				
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)			
			3 - 5 in	5 - 12 in	PLUS 12 in	
1	(SM)gc	0.0 to 2.1 ft SILTY SAND WITH GRAVEL AND COBBLES: About 50% hard subrounded gravel; about 30% non plastic fines, rapid dilatancy and no dry strength; about 20% fine sand; trace of cobbles; maximum size, cobble; no reaction with HCl.	tr			
2	2.1 ft (5867.1)	IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous.				
3	COBBLES AND BOULDERS	GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd) 2.1 to 11.1 ft COBBLES AND BOULDERS WITH SILTY GRAVEL WITH SAND: TOTAL SAMPLE (BY VOLUME): About 65% 3- to 5-inch hard subrounded to subangular cobbles; about 15% 5- to 12-inch hard, subangular to subrounded cobbles; about 10% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 700 mm.	65	15	10	
4		MINUS 3-inch FRACTION (BY MASS): About 50% hard subrounded gravel; about 30% fine to medium subrounded sand; about 20% nonplastic fines; no reaction with HCl.				
5		IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.				
6		GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd).				
7						
8						
9						
10						
11	11.1 ft (5858.1)					
COMMENTS: Discontinued hole due to limit of equipment and sloughing.  NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid						

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-4</b>		SHEET 1 OF 1	
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT			
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5867.9			
COORDINATES: N 1,884,771 E 2,464,248		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE			
APPROXIMATE DIMENSIONS: 6'X11'X11.5'		LOGGED BY: J. GILBERT			
DEPTH TO WATER: NE DATE: 8/2/2016		DATE EXCAVATED: 8/2/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	COBBLES AND BOULDERS	0.0 to 11.5 ft COBBLES AND BOULDERS WITH SILTY GRAVEL WITH SAND : TOTAL SAMPLE (BY VOLUME): About 60% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 15% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 1000 mm.	60	20	15
2		MINUS 3-inch FRACTION (BY MASS): About 50% hard subrounded gravel; about 30% fine to medium subrounded sand; about 20% nonplastic fines; no reaction with HCl.			
3		IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.			
4		GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)			
5					
6					
7					
8					
9					
10					
11		11.5 ft (5856.4)			
<p>COMMENTS: Discontinued due to limit of equipment. Corrosion sample taken at 10.0 ft.</p> <p>NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid</p>					

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Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPSTR7-16-5		SHEET 1 OF 1		
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT				
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5867.2				
COORDINATES: N 1,884,698 E 2,464,276		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE				
APPROXIMATE DIMENSIONS: 7'X12'X9.5'		LOGGED BY: J. GILBERT				
DEPTH TO WATER: NE DATE: 8/3/2016		DATE EXCAVATED: 8/3/2016				
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)			
			3 - 5 in	5 - 12 in	PLUS 12 in	
1	COBBLES AND BOULDERS	0.0 to 9.5 ft COBBLES AND BOULDERS WITH SILTY SAND : TOTAL SAMPLE (BY VOLUME): About 60% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 15% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 900 mm.  MINUS 3-inch FRACTION (BY MASS): About 80% fine sand; about 20% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.  IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.  GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)	60	20	15	
2						
3						
4						
5						
6						
7						
8						
9						
	9.5 ft (5857.7)					
COMMENTS: Discontinued due to limit of equipment and sloughing sidewalls.  NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid						

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**Technical Memorandum No. ZN-8314-5  
Pumping Plant 4 – Geotechnical Design**

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPSTR7-16-6</b>			SHEET 1 OF 1		
FEATURE: PUMPING PLANT 4		PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT					
LOCATION: PUMPING PLANT 4		GROUND ELEVATION: 5860.5					
COORDINATES: N 1,885,280 E 2,464,196		METHOD OF EXPLORATION: JOHN DEERE 310J BACKHOE					
APPROXIMATE DIMENSIONS: 7'X12'X12'		LOGGED BY: J. GILBERT					
DEPTH TO WATER: NE DATE: 8/3/2016		DATE EXCAVATED: 8/3/2016					
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)				
			3 - 5 in	5 - 12 in	PLUS 12 in		
1	COBBLES AND BOULDERS	0.0 to 12.0 ft COBBLES AND BOULDERS WITH SILTY SAND: TOTAL SAMPLE (BY VOLUME): About 65% 3- to 5-inch hard subrounded to subangular cobbles; about 20% 5- to 12-inch hard, subangular to subrounded cobbles; about 10% plus 12-inch subrounded boulders; remainder minus 3 inch; maximum size, 1000 mm.  MINUS 3-inch FRACTION (BY MASS): About 80% fine sand; about 20% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.  IN-PLACE CONDITION: Dry, tan soil with grey to white sandstone gravels, cobbles and boulders.  GEOLOGIC INTERPRETATION: Quaternary Pediment Deposit (Qpd)	65	20	10		
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12						12.0 ft (5848.5)	
COMMENTS: Discontinued due to limit of equipment.  NE= not encountered NA= not available NP= nonplastic HCl= hydrochloric acid							

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END OF SECTION

**SECTION 53 50 00**  
**GEOLOGIC DESIGN DATA REPORT – SAN JUAN LATERAL, PUMPING PLANT 7**

# RECLAMATION

*Managing Water in the West*

## GEOLOGIC DESIGN DATA REPORT

### SAN JUAN LATERAL, PUMPING PLANT 7



### NAVAJO GALLUP WATER SUPPLY PROJECT



Department of the Interior  
Bureau of Reclamation  
Upper Colorado Region  
Four Corners Construction Office  
Farmington, New Mexico



September 2016

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**APPENDIX 1**

LOGS OF EXPLORATION

Drill Holes:

DHPP7-16-1, DHPP7-16-2, DHPP7-16-3, DHPP7-16-4, DHPP7-16-5, DHPP7-16-6, DHPP7-16-7, DHPP7-16-8, DHPP7-16-9, DHPP7-16-10, DHPP7-16-11.

Test Pits:

TPPP7-16-1, TPPP7-16-2, TPPP7-16-3, TPPP7-16-4, TPPP7-16-5, TPPP7-16-6, TPPP7-16-7, TPPP7-16-8.

**APPENDIX 2**

LABORATORY DATA

**APPENDIX 3**

PHOTOGRAPHS

**APPENDIX 4**

DRAWINGS

Dwg No. 1695-529-60091 General Map

Dwg No. 1695-529-60064 Location Map

Dwg No. 1695-529-60094 General Geologic Legend, Explanation and Notes

Dwg No. 1695-529-60059 Surface Geology and Location of Exploration

Dwg No. 1695-529-60084 Geologic Cross Sections A-A' and B-B'

## **1.0 INTRODUCTION**

The Navajo-Gallup Water Supply Project (NGWSP) is a major infrastructure project that once constructed, will convey a reliable municipal and industrial water supply from the San Juan River to the eastern section of the Navajo Nation, southwestern portion of the Jicarilla Apache Nation and the city of Gallup, New Mexico. Approximately 280 miles of pipeline, several pumping plants and two water treatment plants are anticipated to be constructed. The NGWSP is divided into two segments, the Eastern phase (Cutter Lateral) and a Western phase (San Juan Lateral).

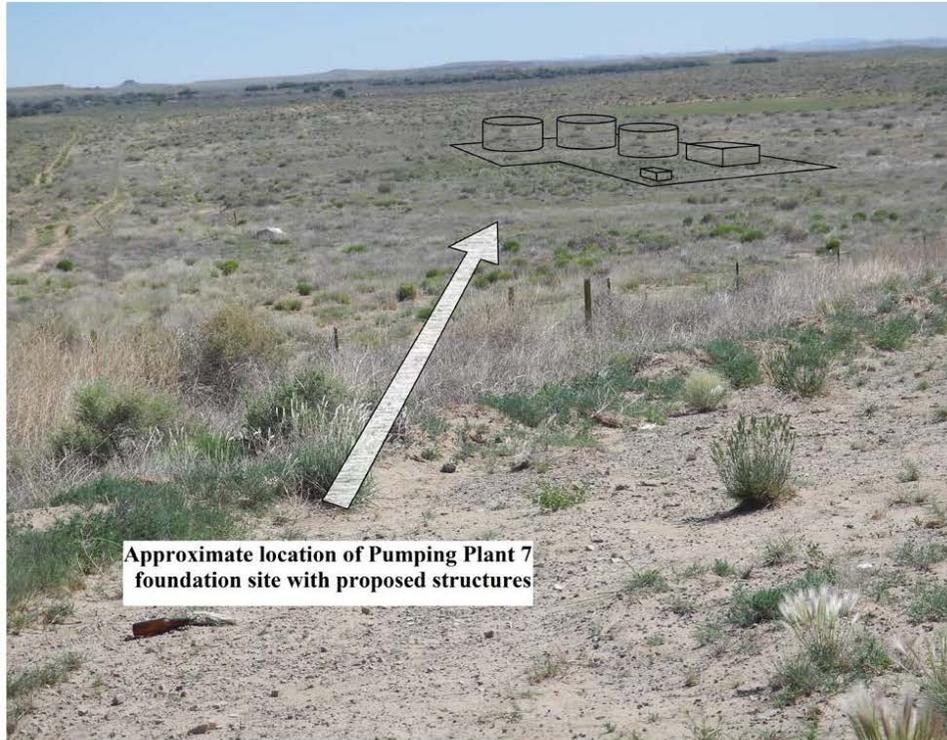
The subject of this report is located on the San Juan Lateral that is divided into several reaches. Pumping Plant 7 is located between Reach 10 and Reach 11 of the pipe alignment. The pumping plant will deliver municipal water to the city of Gallup and surrounding Navajo Chapters.

### **1.1 PURPOSE**

The purpose of this report is to summarize geologic design data investigations for Pumping Plant 7 that is a feature of the NGWSP. Investigations were performed to collect site specific design data for potential buildings, line pipe and water tank foundations. Testing was requested by the Technical Service Center (TSC) to identify any potentially expansive foundation material. This report presents the data collected from February 2016 through July of 2016 from subsurface explorations and geologic mapping.

### **1.2 PROPOSED STRUCTURES**

Proposed structures at Pumping Plant 7 include a pumping plant, three storage tanks, a chlorine disinfection building, a surge tank and several vaults. Pumping Plant 7 will facilitate downstream distribution to subsequent reaches and pumping plants.



**Approximate location of Pumping Plant 7 with the proposed structures illustrated in black.**  
 Reference Image Only

Photo taken on 6/15/2016 by J. Gilbert.

### **1.3 TOPOGRAPHICAL DATA BASE**

Aerial photography was flown in April 6<sup>th</sup> 2010 by Woolpert Inc. GPS survey equipment was used by Reclamation survey crews to locate panel points and the area was flown from approximately 3,600 feet. The topography collected from Woolpert Inc. consists of 2-foot contours using NAD-83 datum. Test pits and drill holes from investigations were located using the Four Corners Construction Office (FCCO) survey crew utilizing survey quality GPS instruments. The coordinates are expressed in 1983 State Plane, New Mexico West Zone.

## 2.0 GEOLOGIC INVESTIGATIONS

Geologic surface mapping at a scale of 1 inch to 100 feet was performed in 2014. Subsurface investigations began in 2016 and consisted of eight test pits (TPPP7-16-1 through TPPP7-16-8) and eleven drill holes (DHPP7-16-1 through DHPP7-16-11). Drill holes were conducted by the FCCO and the Bureau of Reclamation Upper Colorado and Great Plains Drill Crews. Drill hole testing utilized the Standard Penetration Test (SPT) for soil classification and the California Sampler method to extract samples for consolidated swell testing. Drill holes were advanced to depths from 34.0 to 50.0 feet. Ground water was encountered in several drill holes and a monitoring well was installed in DHPP7-16-3 to measure ground water elevation. Test pits were conducted by the FCCO personnel. Cultural monitoring was required for test pits and was provided by PaleoWest Archaeology. Geologic logs, lab results, drawings and photos along with exploration data summary tables are included.

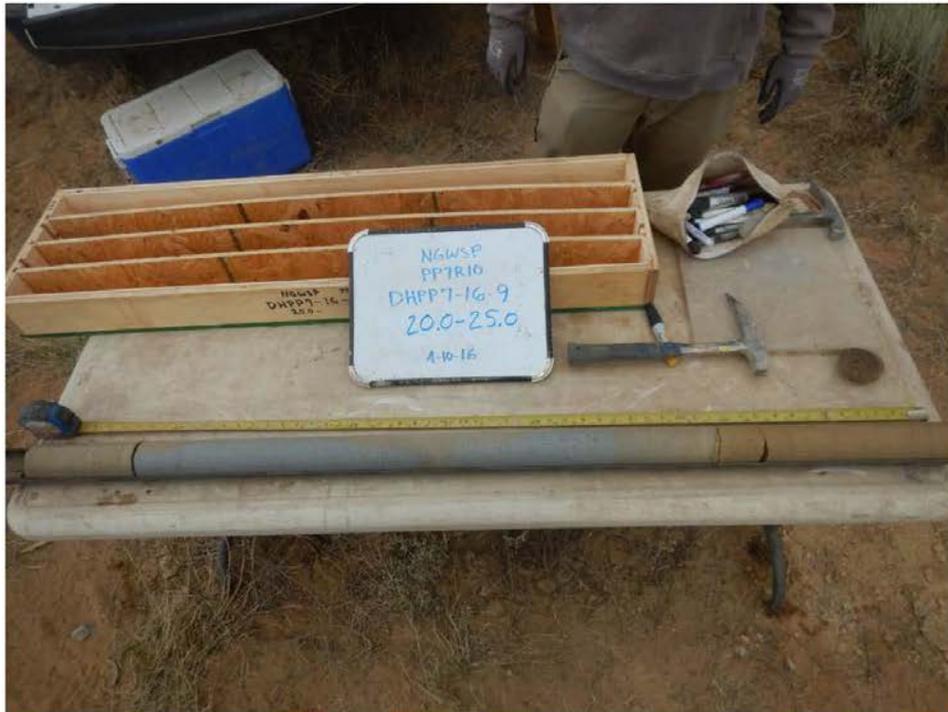
### 2.1 TESTING AND SAMPLING

All soils recovered from test pits and drill holes were logged and visually classified using methods described in USBR 5005 [Earth Manual, Part 2, Third Edition, and the Unified Soil Classification System (USCS)]. Testing conducted by the FCCO Materials Laboratory included in-place densities, Proctor, Atterburg Limits, specific gravity, gradation analysis and laboratory soil classification.

Drilling was completed using a CME 85 truck mounted drill rig. Standard Penetration Testing was conducted using a 4.25 inch diameter by 5 foot long hollow stem auger sampler and a 1.5 inch inside diameter by 2.5 foot long SPT sampler. A 140 pound auto hammer was used to drive the sampler. The SPT sampler was advanced 1.5 feet with blow counts reported per 0.5 foot of advancement. Representative samples were sent to the FCCO Materials Laboratory for laboratory soil classification. Bulk samples were collected from auger cuttings of alluvium and sandstone and sent to the TSC for laboratory testing.

The California Sampler had a 2.5 inch outside, 2 inch inside diameter, with three to four, 4 inch x 1.94 inch brass liners. The central barrel was 16 inches in length. Samples were extracted at depths specified in the field exploration request for the purpose of consolidated swell testing. A

140 pound auto hammer was used to drive the sampler. The sampler was seated with two to three blows where the seated depth was recorded. After seating, blow counts were recorded for every 0.5 foot of advancement. The sampler was advanced 1.0 foot for each test and the bottom two brass liners (A and B) were capped, taped and labeled for laboratory testing. The third brass liner C was occasionally recovered and sent for testing. All suitable samples were carefully packaged and kept inside to prevent freezing. The samples were sent to the TSC laboratory for the consolidated swell test. Soils recovered from the brass liners were logged and visually classified using methods described in USBR 5005.



Fine grain sandstone core colored tan, light brown and gray recovered from DHPP7-16-9.  
Image for reference only. Photo taken on 4/14/2016 by P. Gardner.

Core drilling was conducted using an HQ3 wireline rock coring system with a 2.5 inch diameter split tube sampler. All rock core recovered from the drill holes were visually classified using methods described in the USBR, Engineering Geology Field Manual, Second addition, Volume 1. Some claystone core was wrapped in plastic to preserve moisture and sent to the TSC for analysis. All drill hole logs are included in Appendix 1.

Test pits were excavated using a Deere 310k backhoe with a 24 inch bucket. Excavation, testing and sampling was performed to the limit of the equipment or refusal. Soil testing was conducted by the FCCO Materials Laboratory. In-place densities were taken in test pits TPPP7-16-6 at 6.0 feet and TPPP7-16-8 at 7.0 feet. Results from the in-place densities are shown on test pit logs in Appendix 1, are found in the summary of test results in Appendix 2 and listed below in Table 2.



Test pit excavation along the line pipe alignment of Reach 10 near Pumping Plant 7.

Image for reference only.

Photo taken on 2/11/2016 by P. Gardner.

Corrosion samples from the tank and pumping plant site were collected at 4 feet below ground surface and sent to the TSC for corrosion testing for concrete, steel pipe and cathodic protection design. Corrosion testing will determine if excavation spoils of the soil and rock from the water tank and building foundations may be suitable as engineered backfill. Information regarding the swell and corrosion testing are available by contacting Reclamation TSC, Concrete Geotechnical and Structural Laboratory (CGSL).

**TABLE 1: SUMMARY OF DRILL HOLE INVESTIGATIONS**

DRILL HOLES									
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA							BLOWS/0.5 (feet)
		DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE	
DHPP7-16-1 Pumping Plant	0.0-5.4: SC (Qal)	3.5-5.0	SC-SM	39	61	22	5	5.0	6/17/46
	5.4-39.5: SS (Kmf)	8.5-9.5	California Sample						28/50
DHPP7-16-2 Site Investigation	0.0-8.8: SC (Qal)	4.0-5.5	SC-SM	29	71	24	6	5.1	10/13/12
	8.8-30.0: SS (Kmf)								
DHPP7-16-3 Site Investigation	0.0-2.8: SM (Qal)	3.5-5.0	SM	27	73	NA	NP	3.8	9/7/7
	2.8-4.5: CL (Qal)	8.5-10.0	SM	21	79	NA	NP	3.3	20/32/50
DHPP7-16-4 Site Investigation	4.5-34.7: SS (Kmf)								
	34.7-35.8: CLSTNE (Kmf)								
DHPP7-16-5 Tank	0.0-7.3: SC (Qal)	4.0-5.5	s(CL)	53	47	30	15	6.5	9/14/16
	7.3-34.0: SS (Kmf)								
DHPP7-16-5 Tank	0.0-3.8: SC (Qal)	3.0-4.5	SM	18	82	NA	NP	2.8	13/15/18
	3.8-34.3: SS (Kmf)	8.0-9.5	SM	33	67	NA	NP	7.5	16/49/50
	34.3-34.7: CLSTNE (Kmf)	37.0-38.0	California Sample						50/NA
DHPP7-16-6 Tank	34.7-37.0: SS (Kmf)								
	37.0-37.3: CLSTNE (Kmf)								
	37.3-37.5: SS (Kmf)								
	37.5-38.3: CLSTNE (Kmf)								
	38.3-40.0: SS (Kmf)								
	0.0-3.4: SC (Qal)	3.0-4.5	SM	29	71	NA	NP	4.6	10/15/19
3.4-28.8: SS (Kmf)	5.5-7.0	SM	23	77	NA	NP	4.1	13/34/50	
28.8-29.0: CLSTNE (Kmf)	10.5-12.0	SM	26	74	NA	NP	5.3	33/50/NA	
29.0-34.4: SS (Kmf)	13.0-14.5	SM	29	71	NA	NP	6.4	37/50/NA	
34.4-34.5: CLSTNE (Kmf)	18.0-19.5	SM	27	73	NA	NP	8.6	34/50/NA	
34.5-35.1: SS (Kmf)									
35.1-49.5: CLSTNE (Kmf)									

DRILL HOLES										
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)	LAB TEST DATA							BLOWS/0.5 (feet)	
		DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE		
DHPP7-16-7 Surge Tank	0.0-4.9: SC (Qal) 4.9-38.1: SS (Kmf) 38.1-39.7: CLSTNE (Kmf)	3.0-4.5	s(CL)	56	44	30	16	7.9	6/8/14	
DHPP7-16-8 Chlorine Building	0.0-2.6: SC (Qal) 2.6-38.1: SS (Kmf) 38.1-40.0: CLSTNE (Kmf)	3.0-4.5	SM	38	62	NA	NP	4.7	12/13/14	
DHPP7-16-9 Tank	0.0-6.9: SC (Qal) 6.9-10.3: SM (Qal) 10.3-38.3: SS (Kmf)	3.0-4.5	s(CL)	53	47	28	15	4.9	5/7/7	
	38.3-38.8: CLSTNE (Kmf) 38.8-40.0: SS (Kmf)	8.0-9.5	SM	31	69	NA	NP	6.3	28/45/50	
DHPP7-16-10 Site Investigation	0.0-3.4: SC (Qal) 3.4-6.0: SM (Qal) 6.0-32.7: SS (Kmf) 32.7-33.1: CLSTNE (Kmf) 33.1-40.0: SS (Kmf)	3.0-4.5	SC-SM	36	64	24	7	4.7	8/10/9	
DHPP7-16-11 Site Investigation	0.0-7.3: SC (Qal)	3.0-4.5	SC-SM	40	60	24	6	5.1	6/9/8	
	7.3-10.6: SM (Qal)	8.0-9.5	SC-SM	46	54	25	6	5.6	18/35/50	
	10.6-15.5: SS (Kmf)	15.5-17.4	CL	87	13	40	20	16.2	BAG SAMPLE	
	15.5-17.4: CLSTNE (Kmf) 17.4-39.0: SS (Kmf) 39.0-41.0: CLSTNE (Kmf)	40.0-41.0	California Sample						50/NA	

TABLE 2: SUMMARY OF TEST PIT INVESTIGATIONS

TEST PITS											
EXPLORATION AND LOCATION	VISUAL CLASSIFICATION, GEOLOGIC SYMBOL AND DEPTH (feet)		LAB TEST DATA						COMPACTION TEST		
			DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM	% FINES	% SAND	LIQUID LIMIT	PLASTICITY INDEX	% MOISTURE	IN-PLACE DRY DENSITY	D-VALUE AND MAXIMUM DRY DENSITY
TPPP7-16-1 Tank	0.0-3.7:	SC (Qal)	-	-	-	-	-	-	-	-	-
	3.7-12.0:	SS (Kmf)	-	-	-	-	-	-	-	-	-
TPPP7-16-2 Tank	0.0-3.8:	SC (Qal)	-	-	-	-	-	-	-	-	-
	3.8-9.9:	SS (Kmf)	-	-	-	-	-	-	-	-	-
TPPP7-16-3 Tank	0.0-3.4:	SC (Qal)	-	-	-	-	-	-	-	-	-
	3.4-9.4:	SS (Kmf)	-	-	-	-	-	-	-	-	-
TPPP7-16-4 Pumping Plant	0.0-4.1:	SC (Qal)	-	-	-	-	-	-	-	-	-
	4.1-10.4:	SS (Kmf)	-	-	-	-	-	-	-	-	-
TPPP7-16-5 Surge Tank	0.0-4.5:	SC (Qal)	-	-	-	-	-	-	-	-	-
	4.5-9.7:	SS (Kmf)	-	-	-	-	-	-	-	-	-
TPPP7-16-6 Tank	0.0-2.8:	SC (Qal)	6.0	<i>s(CL)</i>	54	46	25	11	6.9	103.2 <i>lb/ft</i> <sup>3</sup>	<i>D</i> = 91.7 % <i>112.5 lb/ft</i> <sup>3</sup> <i>Opt</i> = 14.5 %
	2.8-12.2:	<i>s(CL)</i> (Qal)									
TPPP7-16-7 Chlorine building	0.0-3.5:	SC (Qal)	-	-	-	-	-	-	-	-	-
	3.5-10.4:	SS (Kmf)	-	-	-	-	-	-	-	-	-
TPPP7-16-8 Outlet Line Pipe	0.0-3.4:	SC (Qal)	7.0	<i>s(CL)</i>	68	32	35	21	9.7	113.8 <i>lb/ft</i> <sup>3</sup>	<i>D</i> = 107.2 % <i>106.2 lb/ft</i> <sup>3</sup> <i>Opt</i> = 17.7 %
	3.4-8.7:	<i>s(CL)</i> (Qal)									
	8.7-10.3:	SS (Kmf)									

### 3.0 REGIONAL GEOLOGY

The San Juan basin is a broad basin that is surrounded by many mountain ranges with distinct geologies, including the Chuska Mountains, the La Plata Mtns, the San Juan Mtns, the San Pedro Mtns, the Zuni Mtns and Mt. Taylor. Characterized by plateaus, mesas and dry-wash canyons presently being eroded in an arid climate, the San Juan Basin is a structural depression and contains Quaternary and Tertiary alluvium, resting on rocks of Tertiary and Cretaceous age which crop out around the margins of the basin. The NGWSP San Juan Lateral is located east of

the Chuska Mountains, near the southwestern margin of the basin north of Gallup, New Mexico. The eastern slope of the Chuska Mountains varies from many types of alluvium to mudflats. Bedrock units which outcrop along this portion of the San Juan Lateral are the Cretaceous Menefee Formation. The bedrock is typically covered on the surface by varying amounts of surficial deposits mapped on the surface as Quaternary Alluvium. The Menefee Formation sandstone generally forms cap rock on the hill tops and the softer claystone and shale units form the lower slopes on the hills.

#### **4.0 SITE GEOLOGY**

Pumping Plant 7 is located on a broad, low-lying alluvial valley known as Tohatchi Flats. This depositional environment is primarily floodplain. The high mountains and low-relief channels seasonal runoff to small drainages and larger washes creating a setting that facilitates flooding and scour. Fine grain sands with clays and silts and sandstone are encountered at the pumping plant foundation.

#### **4.1 STRATIGRAPHY**

The geologic units encountered at the Pumping Plant 7 footprint consists of surficial alluvium on bedrock of sandstone and claystone. The alluvium varies in depth and bedrock is generally found within 6 feet of the ground surface. Sandstone is the predominant bedrock unit with occasional inter-bedded claystone.

##### **4.1.1 SURFICIAL DEPOSITS**

###### **Quaternary Alluvium (Qal)**

Quaternary alluvium deposits overlie bedrock at the investigation site of Pumping Plant 7. Alluvial soils range from Silty Sand (SM), Silty Clayey Sand (SC-SM), to Clayey Sand (SC) and Sandy Lean Clay s(CL). Soils are generally fine grain sands with variable amounts of plastic to non-plastic fines. For more detail, see each specific geologic log. The alluvium is derived from a variety of sources including eolian and alluvial deposition as well as weathering and decomposition of in-place sandstone and claystone bedrock. Quaternary Alluvium is used to describe all surficial deposits regardless of origin.

#### **4.1.2 BEDROCK**

##### **Cretaceous Menefee Formation (Kmf)**

The Cretaceous Menefee Formation consists primarily of light brown, fine-grained sandstone with interbedded claystone, shale and siltstone but can vary in color and grain size. The bedrock locally has a shallow dip toward the northeast. The sandstone can be decomposed (W9) but is generally moderately weathered (W5), moderately soft (H5) to soft (H6) and slightly fractured at the surface. The same sandstone unit, when excavated below ground level, can be moderately hard (H4) and slightly weathered (W3). A hard, iron rich, calcareous sandstone is occasionally inter-bedded within the softer sandstone units. This inter-bedded sandstone is hard (H3) and can only be broken by a heavy hammer blow. The claystone is sandy, light brown to dark gray in color and is generally laminated to thinly bedded. The claystone ranges from moderately to slightly weathered (W4) to intensely to moderately weathered (W6) and soft (H6) to very soft (H7). The claystone often grades to siltstone and occasionally becomes fissile, grading to shale. Claystone intervals encountered ranged from a few inches to 5 feet in thickness.

### **5.0 GEOLOGIC CONSIDERATIONS**

Concerns about the safety surrounding the geologic environment range from the stability of slopes in excavations, excavation methods to the presence of utilities and ground water. Specific situations are addressed below.

#### **5.1 STABILITY OF EARTH MATERIALS**

This section includes information on natural slope stability and recommends temporary and permanent cut slopes for both surficial deposits and bedrock. The stability of cut slopes is dependent upon the composition of materials and moisture conditions

##### **5.1.1 NATURAL SLOPE STABILITY**

The stability of surficial deposits in the foundation area is dependent primarily on material composition. Natural slopes in consolidated alluvium are generally stable at approximately 1.5:1 or flatter in sandy materials. Bedrock exposures in the area are typically stable at about 1.5:1 or steeper in claystone and shale, and 1:1 to vertical in sandstone.

### 5.1.2 TEMPORARY AND PERMANENT CUT SLOPES

Recommendations for cut slopes in surficial deposits are based on material type and texture. All cut slopes shall be constructed in accordance with the Reclamation Safety and Health Standards and OSHA standards. Recommendations are for dry or adequately dewatered materials.

Materials with excessive moisture will require further flattening for stability. Recommended cut slopes for type C soils, including Poorly Graded Sand (SP), Poorly Graded Sand with Silt (SP-SM), and Silty Sand (SM), are 1.5:1. Recommended cut slopes for type B soils, including Silty Clayey Sand (SC-SM), Clayey Sand (SC) and Sandy Lean Clay s(CL) are 1:1 or flatter.

Cut slopes in bedrock will be dependent upon the rock type and degree of weathering. All decomposed to intensely weathered, very soft to soft bedrock will be classified as a type B or type C soils depending upon the composition of the rock. Moderately weathered to fresh, moderately soft to hard bedrock can be classified as Stable Rock if all requirements of the Reclamation Safety and Health Standards are met. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

### 5.2 EXCAVATION CONSIDERATIONS

Excavation for most of the Pumping Plant 7 footprint is generally expected to be within 2 to 6 feet of alluvium on top of the sandstone. Deeper excavation will be primarily in sandstone. Test pits were easily excavated using common methods. Consolidated soils and intensely weathered to decomposed bedrock can be excavated using common methods. Rock weathering transitions from decomposed and becomes less weathered with depth in sandstone.

A hard layer of sandstone was encountered from 11.3 to 13.8 feet in DHPP7-16-1, 17.5 to 21.0 feet in DHPP7-16-3, 17.0 to 21.5 feet in DHPP7-16-4, 15.0 to 15.6 feet in DHPP7-16-6, 17.0 to 18.8 feet in DHPP7-16-7, 24.3 to 26.0 feet in DHPP7-16-8, 20.0 to 23.8 feet in DHPP7-16-9 and 26.5 to 32.7 feet in DHPP7-16-10. If encountered during excavations, this interval could be difficult for some excavation equipment. Claystone units of the Menefee Formation are often weathered and soft and if encountered, will likely be excavated by ripper-equipped dozers or large excavators with adequate pullout force and appropriate teeth. Claystone was encountered at 15.5 feet in DHPP7-16-11 but is typically found below 25 feet in drill holes. Industrial

equipment should be expected to accomplish foundation excavation. Test pit TPPP7-16-6 was excavated to a depth of 12.2 feet in the northwest corner of the foundation and did not encounter bedrock. Drill hole DHPP7-16-9 was completed at the northwest tank location and encountered sandstone at 10.3 feet of advancement.

### **5.2.1 UTILITIES**

KinderMorgan, Inc. has acquired the El-Paso Pipeline that is within 100 feet to the west of the Pumping Plant 7 foundation. Special care should be taken with these four natural gas pipelines. The pipe is under pressure and is within a few feet of the ground surface. Arrangement must be made with KinderMorgan to avoid heavy equipment travel to and from the site that could damage the pipe.

### **5.2.2 GROUND WATER OCCURRENCE**

Ground water was encountered in drill holes DHPP7-16- 2, 3, 5 and 11. A monitoring well was installed in DHPP7-16-3 and was measured at 30.7 feet below ground surface in July of 2016. Dry core drilling in DHPP7-16-2 measured the ground water at 29.8 feet in July of 2016. Drill holes DHPP7-16-5 and 11 encountered ground water at 31.5 and 39.0 feet respectively in April of 2016. Ground water is not expected to be encountered at shallow depths. There is an artesian well located less than 1000 feet to the northwest of the site. The well is approximately 5 feet lower in elevation than the foundation investigation site.

### **5.3 SCOUR POTENTIAL**

Scour potential should not be an issue when excavations are properly sloped and storm water run-off is addressed. A small ponding area approximately 300 feet northeast of the foundation may require attention during heavy precipitation events.

## **6.0 REFERENCES**

USBR 5005 [Earth Manual, Part 2, Third Edition, and the Unified Soil Classification System (USCS)].

USBR, Engineering Geology Field Manual, Second Edition, volume 1.

# **APPENDIX 1**

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GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-1												SHEET 1 OF 1				
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project			STATE: New Mexico			GROUND ELEVATION: 6212.4 ft. NAD-83							
LOCATION: Pumping Plant			COORDINATES: N 1,729,194.4 E 2,454,357.6 83 State Plane			ANGLE FROM HORIZONTAL: 90										
BEGIN: 4/6/16 FINISHED: 4/7/16			TOTAL DEPTH: 39.5			HOLE LOGGED BY: P. Gardner										
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 5.4			REVIEWED BY: J. Gilbert										
DATE MEASURED: 4/7/2016																
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killebrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 8.5: 4.25 inch HSA and dry core system with SPT. 8.5 to 11.3: 4.25 inch HSA and dry core system with California Sampler. 11.3 to 39.5: HQ3 wireline coring system with 5 foot split tube sampler and carbide surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 11.3: None 11.3 to 39.5: Water</p> <p>DRILLING NOTES: 0.0 to 3.5: Pilot bit. 3.5 to 11.3: Dry core, easy auger to refusal. 11.3 to 24.5: HQ3 Easy drilling 24.5 to 29.5: HQ3 No recovery, easy drilling. 29.5 to 34.5: HQ3 Easy drilling, difficult to recover core. 34.5 to 39.5: HQ3 Easy drilling, difficult to recover core because of washed sandstone. Lost bit in hole at 39.5. Abandoned hole.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following intervals for swell and laboratory testing 3.5 to 5.0: SPT 8.5 to 9.5: California Sample</p>	0.0	Qal													0.0 to 5.4 ft QUATERNARY ALLUVIUM (Qal)	
	5.0															0.0 to 5.4 ft CLAYEY SAND (SC): About 70% fine sand; about 30% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Brown and dry.
	5.4															5.4 to 39.5 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
	5.4															5.4 to 11.3 ft SANDSTONE: Fine grained, tan to light brown and orange. Moderately soft (H5) and can be grooved with knife. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes and FeOx and CaCOx in joints. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.
	11.3															11.3 to 13.8 ft SANDSTONE: Fine grained, light to dark gray in color. Hard (H3) and difficult to scratch with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Strong reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. Highly fractured zone between 13.3 and 13.5 ft.
	13.8															JOINT MEASUREMENTS: DEPTH INCL R O T HL INFILLING 12.5 10° 5 0 0 1 FeOx
	13.8															13.8 to 34.5 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be grooved with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes vary from 10° to near horizontal. No recovery between 24.5 and 29.5 ft.
	24.5															34.5 to 39.5 ft SANDSTONE: No recovery. Core washed away with cuttings.
	24.5															STRATIGRAPHY: 0.0 to 5.4 ft: QUATERNARY ALLUVIUM (Qal) 5.4 to 39.5 ft: CRETACEOUS MENEFFEE FORMATION (Kmf)
	29.5															
34.5																
39.5																
															6172.9	
BOTTOM OF HOLE																

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

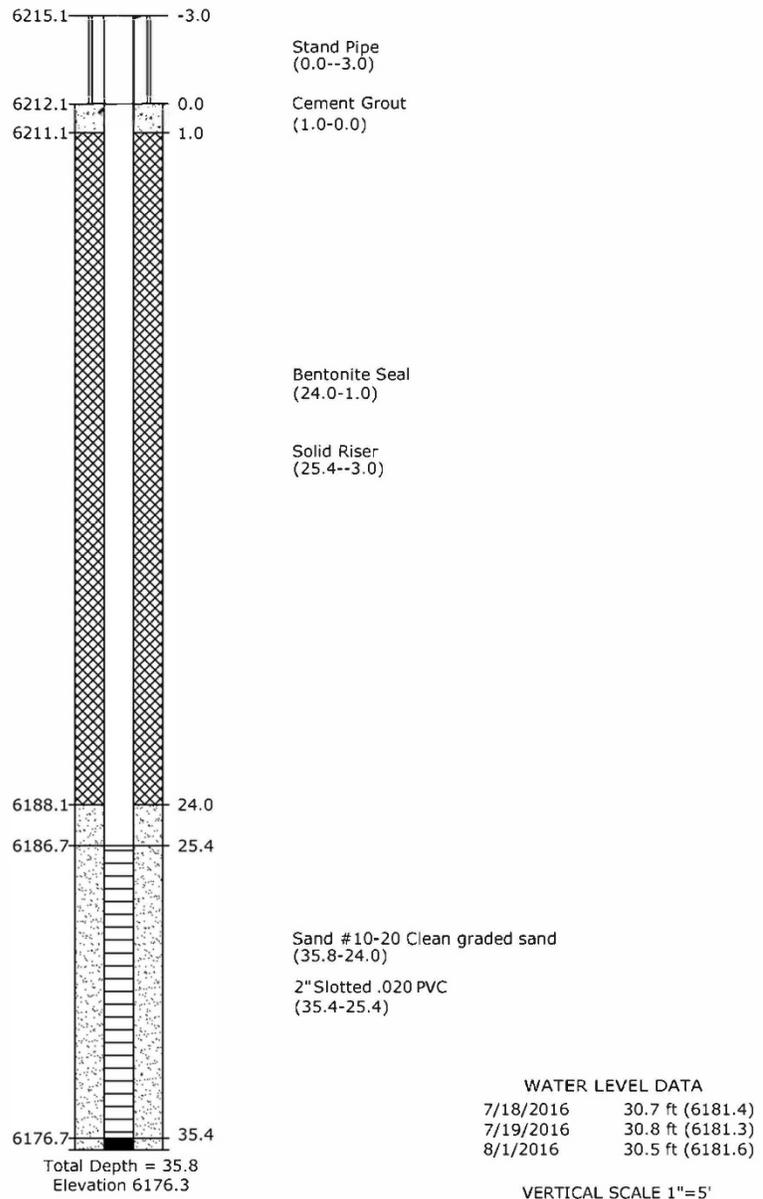
The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.

GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-2													SHEET 1 OF 1			
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Foundation Investigation			COORDINATES: N 1,729,464.4 E 2,454,630.5 83 State Plane				GROUND ELEVATION: 6210.5 ft. NAD-83									
BEGUN: 7/19/16 FINISHED: 7/19/16			TOTAL DEPTH: 30.0				ANGLE FROM HORIZONTAL: -90									
DEPTH AND ELEVATION OF WATER LEVEL: 29.8 ft. (6180.7)			DEPTH TO BEDROCK: 8.8				HOLE LOGGED BY: C. Beyer									
DATE MEASURED: 7/19/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Ruben Perez HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 30.0. 4.25 inch HSA and dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 30.0. None</p> <p>DRILLING NOTES: Core chewed up by auger, recovered as thin wafers.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLES: Sampled following interval for laboratory testing. 4.0 to 5.5. SPT</p>															0.0 to 8.8 ft QUATERNARY ALLUVIUM (Qal)	
		42														0.0 to 8.8 ft CLAYEY SAND (SC): About 75% fine sand; about 25% fines with medium plasticity, medium toughness, medium dry strength and slow dilatancy; maximum size, fine sand; strong reaction with HCl.
		5	Qal					28.8	71.2	0.0	24.0	6.2	5.1	SC-SM	10/13/12	8.8 to 30.0 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
		26														8.8 to 30.0 ft SANDSTONE: Fine grained, light to dark brown and orange, very soft (H7) to soft (H16), moderately to intensely weathered (W5), thinly to moderately bedded, bedding planes near horizontal. Core separates along bedding planes, FeOx staining, weak reaction with HCl. Core becomes moist below 16.0 ft. and wet from 29.5 to 30.0 ft. Groundwater measured at 29.8 ft before backfilling hole.
		6201.7														STRATIGRAPHY: 0.0 to 8.8 ft: QUATERNARY ALLUVIUM (Qal) 8.8 to 30.0 ft: CRETACEOUS MENEFFEE FORMATION (Kmf)
		10				7	8									
		100														
		15			NA											
		100														
		20	Kmf			6	6									SS
	100															
	25															
	100															
	30														6180.5	
BOTTOM OF HOLE																
<p><b>COMMENTS:</b></p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																



Piezometer Number/Hole: DHPP7-16-3  
 Date: 7/19/16  
 Station: N/A Offset: N/A  
 Surface Elevation: 6212.1  
 Type of Piezometer: Monitoring Well  
 Tip Elevation: 6215.1  
 Influence Zone Interval: 6186.7-6176.7

### Completion Diagram



GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-4													SHEET 1 OF 1				
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico										
LOCATION: Foundation Investigation			COORDINATES: N 1,729,002.1 E 2,454,346.7 83 State Plane				GROUND ELEVATION: 6214.3 ft. NAD-83										
BEGIN: 7/18/16 FINISHED: 7/18/16			TOTAL DEPTH: 34.0				ANGLE FROM HORIZONTAL: 90										
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 7.3				HOLE LOGGED BY: C. Beyer										
DATE MEASURED: 7/18/2016							REVIEWED BY: J. Gilbert										
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION		
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION	
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Ruben Perez HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 19.0: 4.25 inch HSA and dry core system. 19.0 to 21.5: 4.25 inch HSA with pilot bit. 21.5 to 34.0: 4.25 inch HSA and dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 34.0: None</p> <p>DRILLING NOTES: Reached hard sandstone at 17.0. Augering was very slow and difficult for about 40 minutes. Crew switched to pilot bit to penetrate hard sandstone bed without sampling from 19.0 to 21.5.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLES: Sampled following interval for laboratory testing. 4.0 to 5.5: SPT</p>	0.0	Cal	87												0.0 to 7.3 ft QUATERNARY ALLUVIUM (Cal)		
	5						52.9	47.1	0.0	29.6	15.1	6.5	s(Cl)	9/14/16	SC	7.3 to 34.0 ft CRETACEOUS MENEFFEE FORMATION (Kmf)	
	7.3														6207.0	7.3 to 17.0 ft SANDSTONE: Fine grained, light to dark brown and orange. Very soft (H7) to soft (H6), moderately to intensely weathered (W6), thinly to moderately bedded, bedding planes near horizontal. Core separates along bedding planes, FeOx staining, weak reaction with HCl.	
	10					7	7									17.0 to 21.5 ft SANDSTONE: Fine grained, gray in color and calcareous. Hard (H3), slightly weathered to fresh (W3), thinly to moderately bedded. Strong reaction with HCl.	
	15					6	5									21.5 to 34.0 ft SANDSTONE: Fine grained, light to dark brown and orange. Soft (H6), moderately weathered (W5), thinly to moderately bedded, bedding planes near horizontal. Core separates along bedding planes, FeOx staining and weak reaction with HCl. Core recovered in thin wafers.	
	17.0															STRATIGRAPHY: 0.0 to 7.3 ft: QUATERNARY ALLUVIUM (Cal) 7.3 to 34.0 ft: CRETACEOUS MENEFFEE FORMATION (Kmf)	
	20															SS	
	21.5																
	25																
	30																
																6180.3	
BOTTOM OF HOLE																	

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.

GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-5												SHEET 1 OF 1				
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Tank			COORDINATES: N 1,729,461.0 E 2,454,481.2 83 State Plane				GROUND ELEVATION: 6211.0 ft. NAD-83									
BEGIN: 4/9/16 FINISHED: 4/10/16			TOTAL DEPTH: 40.0				ANGLE FROM HORIZONTAL: 90									
DEPTH AND ELEVATION OF WATER LEVEL: 31.5 ft. (6179.5)			DEPTH TO BEDROCK: 3.8				HOLE LOGGED BY: P. Gardner									
DATE MEASURED: 4/10/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killebrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 9.5: 4.25 inch HSA and dry core system with SPT. 9.5 to 37.0: 4.25 inch HSA and dry core system. 37.0 to 38.0: 4.25 inch HSA and dry core system with California Sampler. 38.0 to 38.5: 4.25 inch HSA and dry core system 38.5 to 40.0: 4.25 inch HSA and dry core system with Pilot Bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 26.5: None 26.5 to 40.0: Water</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit 3.0 to 37.0: Dry core, easy auger. Wet at 28.0. 37.0 to 38.5: Dry core, difficult to auger to refusal. 38.5 to 40.0: HSA with pilot bit, no recovery.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following intervals for swell and laboratory testing 3.0 to 4.5: SPT 8.0 to 9.5: SPT 37.0 to 38.0: California Sample</p>	0.0	Qal													0.0 to 3.8 ft QUATERNARY ALLUVIUM (Qal)	
	3.8						18.2	81.8	0.0	NA	NP	2.8	SM	13/15/18	6207.2	3.8 to 40.0 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
	5.0			90												3.8 to 34.3 ft SANDSTONE: Fine grained, tan to light brown and orange. Soft (H6) and can be grooved with thumbnail. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes with FeOx staining and CaCO3. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. Carbonaceous interval found between 33.4 and 33.5 ft.
	10.0			100			43.4	66.6	0.0	NA	NP	7.5	SM	16/49/50		34.3 to 34.7 ft CLAYSTONE: Light to dark gray and black. Soft (H6) and can be scratched with thumbnail. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. No reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.
	15.0			100												34.7 to 37.0 ft SANDSTONE: Fine grained, light to dark brown and orange. Moderately soft (H5) and can be grooved with a knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal.
	20.0			100	NA	6	7								SS	37.0 to 37.3 ft CLAYSTONE: Fine grained, light to dark gray and black. Soft (H6) and can be easily scratched with thumbnail. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. No reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.
	25.0			100												37.3 to 37.5 ft SANDSTONE: Fine grained, light to dark brown and orange. Moderately soft (H5) and can be grooved with a knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal.
	30.0			100												37.5 to 38.3 ft CLAYSTONE: Light to dark gray and black. Soft (H6) and can be scratched with thumbnail. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. No reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.
	35.0			96		5									SS	38.3 to 40.0 ft SANDSTONE: Fine grained, light to dark brown and orange. Moderately soft (H5) to moderately hard (H4). Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal. HSA with pilot bit, no recovery from 38.5 to 40.0 ft.
	40.0			NR		5-4	4								SS	<p>STRATIGRAPHY:</p> <p>0.0 to 3.8 ft: QUATERNARY ALLUVIUM (Qal) 3.8 to 40.0 ft: CRETACEOUS MENEFFEE FORMATION (Kmf)</p>
BOTTOM OF HOLE																

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTONE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.

GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-6												SHEET 1 OF 1				
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project			STATE: New Mexico			GROUND ELEVATION: 6211.0 ft. NAD-83							
LOCATION: Tank			COORDINATES: N 1,729,341.5 E 2,454,402.4 83 State Plane			ANGLE FROM HORIZONTAL: 90			HOLE LOGGED BY: P. Gardner							
BEGIN: 4/9/16 FINISHED: 4/9/16			TOTAL DEPTH: 49.5			DEPTH TO BEDROCK: 3.4			REVIEWED BY: J. Gilbert							
DEPTH AND ELEVATION OF WATER LEVEL: NE																
DATE MEASURED: 4/9/2016																
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killebrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 21.5: 4.25 inch HSA and dry core system with SPT. 21.5 to 23.0: 4.25 inch HSA and dry core system with Pilot Bit. 23.0 to 49.5: HQ3 wireline coring system with 5 foot split tube sampler and carbide surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 23.0: None 23.0 to 49.5: Water</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit. 3.0 to 21.5: Dry core, easy auger to refusal. 21.5 to 23.0: HSA with pilot bit. No recovery. 23.0 to 29.5: HQ3 Typical drilling. 29.5 to 34.5: HQ3 Poor recovery, washed by drill. 34.5 to 49.5: HQ3 Easy drilling.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following intervals for laboratory testing. 3.0 to 4.5: SPT 5.5 to 7.0: SPT 10.5 to 12.0: SPT 13.0 to 14.5: SPT 18.0 to 19.5: SPT</p>		Cal													0.0 to 3.4 ft QUATERNARY ALLUVIUM (Cal)	
	5		100			3	28.8	71.2	0.0	NA	NP	4.6	SM	19/15/19	SC	0.0 to 3.4 ft CLAYEY SAND (SC): About 80% fine sand; about 20% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Light brown and moist.
																3.4 to 49.5 ft CRETACEOUS MENEFFEE FORMATION (Kmf)
		10		94		7	22.9	77.1	0.0	NA	NP	4.1	SM	13/34/50		3.4 to 7.7 ft SANDSTONE: Fine grained, tan to light brown. Decomposed (W9) and softer than (H7) and can be classified as "SILTY SAND" with about 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; no to weak reaction with HCl. Light brown and moist. Clayclasts found between 7.0 and 7.7 ft.
		15		100		7	25.5	74.5	0.0	NA	NP	5.3	SM	33/50/NA		7.7 to 15.0 ft SANDSTONE: Fine grained, tan to light brown and orange. Moderately soft (H5) and can be easily grooved with knife. Intensely weathered (W7) discolored and oxidized throughout. Easily broken on bedding planes and FeOx and CaCOx in joints. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. Carbonaceous blebs and lamination present.
		20		100		5	28.5	71.5	0.0	NA	NP	6.4	SM	37/50/NA		15.0 to 15.6 ft SANDSTONE: Fine grained, light gray in color. Hard (H3) and difficult to scratch with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Strong reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. Highly fractured.
		25		NR												15.6 to 35.1 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be easily grooved with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal. No recovery between 27.5 and 23.0 ft. Claystone interval between 28.8 and 29.0 ft and between 34.4 and 34.5 ft.
		30	Kmf	64	0	5										35.1 to 49.5 ft CLAYSTONE: Light to dark gray and mottled with black and red. Soft (H6) and can be scratched with thumbnail. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. No reaction with HCl. FeOx staining present. Laminated to thinly bedded. Bedding planes vary from 10° to near horizontal.
		35		100	94											STRATIGRAPHY: 0.0 to 3.4 ft: QUATERNARY ALLUVIUM (Cal) 3.4 to 49.5 ft: CRETACEOUS MENEFFEE FORMATION (Kmf)
		40		100	92											CLSTNE
		45		100	92											6161.5
	BOTTOM OF HOLE															
<p><b>COMMENTS:</b></p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																
												SHEET 1 OF 1		DRILL HOLE: DHP7-16-6		

GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-7												SHEET 1 OF 1					
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico										
LOCATION: Surge Tank			COORDINATES: N 1,729,119.0 E 2,454,294.3 83 State Plane				GROUND ELEVATION: 6213.7 ft. NAD-83										
BEGIN: 4/12/16 FINISHED: 4/12/16			TOTAL DEPTH: 39.7				ANGLE FROM HORIZONTAL: 90										
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 4.9				HOLE LOGGED BY: P. Gardner										
DATE MEASURED: 4/12/2016							REVIEWED BY: J. Gilbert										
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA						BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION		
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				LABORATORY CLASSIFICATION	
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killebrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 4.5: 4.25 inch HSA and dry core system with SPT. 4.5 to 17.0: 4.25 inch HSA and dry core system. 17.0 to 18.0: 4.25 inch HSA and dry core system with Pilot Bit. 18.0 to 39.7: HQ3 wireline coring system with 5 foot split tube sampler and carbide surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 18.0: None 18.0 to 39.7: Water</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit. 3.0 to 17.0: Dry core, easy auger to refusal. 17.0 to 18.0: HSA with pilot bit. No recovery. 18.0 to 19.7: HQ3 Easy drilling. 19.7 to 24.7: HQ3 Poor recovery, washed by drill. 24.7 to 29.7: HQ3 Easy drilling. 29.7 to 34.7: HQ3 Poor recovery, washed by drill. 34.7 to 39.7: HQ3 Easy drilling.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following interval for laboratory testing: 3.0 to 4.5: SPT</p>		Qal													0.0 to 4.9 ft QUATERNARY ALLUVIUM (Qal)		
		5		80		7	55.8	44.2	0.0	30	15.5	7.9	e(Cl)	6/9/14	SC	0.0 to 4.9 ft CLAYEY SAND (SC): About 70% fine sand; about 30% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Brown and dry.	
		10		100		7									6208.9	4.9 to 39.7 ft CRETACEOUS MENEFFEE FORMATION (Kmf)	
		15		98		5										4.9 to 10.3 ft SANDSTONE: Fine grained, tan to light brown. Very soft (H7) and can be gouged with fingernail. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes and FeOx and CaCO3 in joints. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.	
		20		NR		3	4									10.3 to 17.0 ft SANDSTONE: Fine grained, tan to light brown. Moderately soft (H5), can be scratched with moderate pressure of a knife. Intensely weathered (W7), discolored and oxidation throughout. Friable and FeOx staining. Thinly to moderately bedded near horizontal. Separates on bedding planes. No reaction with HCl.	
		25		100	0	5	7									17.0 to 18.8 ft SANDSTONE: Fine grained and gray. Hard (H3) and moderately to slightly weathered (W4). Strong reaction with HCl. HSA with pilot bit and no recovery between 17.0 and 18.0 ft.	
		30		20	0										SS	18.8 to 39.1 ft SANDSTONE: Fine grained, tan and light to dark brown. Moderately soft (H5) to soft (H6) and can be easily grooved with knife. Intensely weathered (W7) becoming intensely to moderately weathered (W6) below 19.4 ft. Friable, easily broken on bedding planes. FeOx and MnOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes from 10° to horizontal. Clay rip up clasts from 28.5 to 34.2 ft.	
		35		100	36											6125.6	39.1 to 39.7 ft CLAYSTONE: Light to dark gray. Soft (H5) and can be scratched with thumbnail. Moderately weathered (W5) with discoloration and oxidation. Laminated to moderately bedded. No reaction with HCl.
				40	14											6124.0	STRATIGRAPHY: 0.0 to 4.9 ft: QUATERNARY ALLUVIUM (Qal) 4.9 to 39.7 ft: CRETACEOUS MENEFFEE FORMATION (Kmf)
						6	5									CLSTNE 6124.0	
																	BOTTOM OF HOLE

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.



GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-9												SHEET 1 OF 1					
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project			STATE: New Mexico			GROUND ELEVATION: 6212.6 ft. NAD 83								
LOCATION: Tank			COORDINATES: N 1,729,524.4 E 2,454,377.4 83 State Plane			ANGLE FROM HORIZONTAL: 90			HOLE LOGGED BY: P. Gardner								
BEGIN: 4/10/16 FINISHED: 4/10/16			TOTAL DEPTH: 40.0			DEPTH TO BEDROCK: 10.3			REVIEWED BY: J. Gilbert								
DEPTH AND ELEVATION OF WATER LEVEL: NE																	
DATE MEASURED: 4/10/2016																	
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killebrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 9.5: 4.25 inch HSA and dry core system with SPT. 9.5 to 20.0: 4.25 inch HSA and dry core system. 20.0 to 20.0: 4.25 inch HSA and dry core system with Pilot Bit. 20.0 to 40.0: HQ3 wireline coring system with 5 foot split tube sampler and carbide surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 20.0: None 20.0 to 40.0: Water</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit 3.0 to 20.0: Dry core, easy auger to refusal. 20.0 to 20.0: HSA with pilot bit with no advancement. 20.0 to 40.0: HQ3 Easy drilling. Water loss at 33.0.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following intervals for laboratory testing. 3.0 to 4.5: SPT 8.0 to 9.5: SPT</p>	0.0														0.0 to 10.3 ft QUATERNARY ALLUVIUM (Qal)		
	5	Qal	68				52.9	47.1	0.0	28.3	14.7	4.9	s(CL)	5/7/7	SC	0.0 to 6.9 ft CLAYEY SAND (SC): About 75% fine sand; about 25% fines with medium plasticity, medium toughness, medium dry strength and slow dilatancy; maximum size, fine sand; strong reaction with HCl.	
																6.9 to 10.3 ft SILTY SAND (SM): About 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; no to weak reaction with HCl. Light brown and moist.	
																10.3 to 40.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)	
		10		98				31.3	68.7	0.0	NA	NP	6.3	SM	28/45/50	SM	10.3 to 20.0 ft SANDSTONE: Fine grained, light to dark brown. Soft (H5) and can be easily grooved with thumbnail. Intensely weathered (W7), friable, easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal.
		15		100		6	7									20.0 to 23.8 ft SANDSTONE: Fine grained, light gray to light brown in color. Hard (H3) and difficult to scratch with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Strong reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.	
		20		100												23.8 to 38.3 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be easily grooved with knife. Sandstone becomes moderately hard (H4) below 25.6 ft. Intensely to moderately weathered (W8). Easily broken on bedding planes and FeOx staining present. No reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal. Carbon fragments found in bedding planes. Small, 3mm, clay rip-up clasts found between 23.8 and 25.6 ft.	
		25	Kmf	94	88	3	4									38.3 to 38.8 ft CLAYSTONE: Light to dark gray and mottled with brownish yellow and red. Very soft (H7) and can be scratched with thumbnail. Intensely to moderately weathered (W5). No reaction with HCl. FeOx staining present. Laminated to thinly bedded. Bedding planes vary from 10° to near horizontal.	
		30		98	84	5										38.8 to 40.0 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be easily grooved with knife. Intensely to moderately weathered (W8). Easily broken on bedding planes and FeOx staining present. No reaction with HCl. Laminated to moderately bedded. Carbonaceous laminations present. Bedding planes near horizontal.	
		35		50	50	4	6									STRATIGRAPHY: 0.0 to 10.3 ft: QUATERNARY ALLUVIUM (Qal) 10.3 to 40.0 ft: CRETACEOUS MENEFEE FORMATION (Kmf)	
	40		96	0	7										CLSTNE SS 6172.6		
BOTTOM OF HOLE																	

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.



GEOLOGIC LOG OF DRILL HOLE NO. DHPP7-16-11												SHEET 1 OF 1				
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project				STATE: New Mexico									
LOCATION: Foundation Investigation			COORDINATES: N 1,729,115.7 E 2,454,147.0 83 State Plane				GROUND ELEVATION: 6215.1 ft. NAD-83									
BEGIN: 4/11/16 FINISHED: 4/11/16			TOTAL DEPTH: 41.0				ANGLE FROM HORIZONTAL: 90									
DEPTH AND ELEVATION OF WATER LEVEL: 39.0 ft. (6176.1)			DEPTH TO BEDROCK: 7.3				HOLE LOGGED BY: P. Gardner									
DATE MEASURED: 4/11/2016							REVIEWED BY: J. Gilbert									
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killebrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 9.5: 4.25 inch HSA and dry core system with SPT. 9.5 to 40.0: 4.25 inch HSA and dry core system. 40.0 to 41.0: 4.25 inch HSA and dry core system with California Sampler.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 41.0: None</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit. 3.0 to 41.0: Dry core, easy auger. Water level measured at 39.0.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following intervals for swell and laboratory testing: 3.0 to 4.5: SPT 8.0 to 9.5: SPT 15.5 to 17.4: Bag sample 40.0 to 41.0: California Sample</p>	0.0														0.0 to 7.3 ft QUATERNARY ALLUVIUM (Qal)	
	5	Qal	64				39.5	60.5	0.0	23.5	5.9	5.1	SC-SM	6/9/8	SC	0.0 to 7.3 ft CLAYEY SAND (SC): About 70% fine sand; about 30% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Brown and dry.
																7.3 to 10.6 ft CRETACEOUS MENEPEE FORMATION (Kmf)
															6207.8	7.3 to 10.6 ft SANDSTONE: Fine grained, tan to light brown. Very soft (H7), decomposed (W9) and can be described as "SILTY SAND" with about 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl.
																10.6 to 15.5 ft SANDSTONE: Fine grained, tan to light brown and orange. Soft (H6) and can be scratched with thumbnail. Intensely weathered (W7) discolored and oxidation throughout. Friable and FeOx staining present. No to weak reaction with HCl.
																15.5 to 17.4 ft CLAYSTONE: Dark brown. Soft (H6) and can be scratched with thumbnail. Moderately weathered (W5) with discoloration and oxidation. No reaction with HCl. FeOx staining present.
																17.4 to 23.8 ft SANDSTONE: Fine grained, tan to light brown. Very soft (H7) and can be easily scratched with thumbnail. Intensely weathered (W7) discolored and oxidation throughout. Friable and FeOx staining present. No to weak reaction with HCl.
																23.8 to 28.0 ft SANDSTONE: Fine grained and brownish yellow. Moderately soft (H5) and can be grooved with a knife with moderate pressure. Intensely weathered (W7) discolored and oxidation throughout. FeOx staining present. No to weak reaction with HCl.
																28.0 to 39.0 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be grooved with a knife with moderate pressure. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal. Clay rip-up clasts found from 33.2 to 33.7 ft.
																39.0 to 41.0 ft CLAYSTONE: Dark gray. Soft (H6) and can be scratched with thumbnail. Moderately weathered (W5) with discoloration and oxidation. No reaction with HCl.
																STRATIGRAPHY: 0.0 to 7.3 ft: QUATERNARY ALLUVIUM (Qal) 7.3 to 41.0 ft: CRETACEOUS MENEPEE FORMATION (Kmf)
																6176.1
															6174.1	
															50/NA	
																BOTTOM OF HOLE

**COMMENTS:**

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6498 Standard Descriptors and Descriptive Criteria for Discontinuities.

# **APPENDIX 2**

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## SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Pumping Plant 7

Page 1 of 3

SAMPLE NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	PARTICLE SIZE FRACTIONS IN PERCENT							CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES		SAND #200 (0.075mm) to #4 (4.75mm)	GRAVEL #4 (4.75mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - pcf	FILL MOISTURE CONTENT - %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %	
			SMALLER THAN 0.005mm	0.005 to 0.075mm																
DHPP7-16-1 SPT#1	3.5-5.0	SC-SM	24.4	14.5	61.1	0.0	0.0	0.0	22.2	4.5	-	-	5.0	-	2.61	-	-	-	-	
DHPP7-16-2 SPT#1	4.0-5.5	SC-SM	22.0	6.8	71.2	0.0	0.0	0.0	24.0	6.2	-	-	5.1	-	2.63	-	-	-	-	
DHPP7-16-3 SPT#1	3.5-5.0	SM	18.9	8.1	73.0	0.0	0.0	0.0	NA	NP	-	-	3.8	-	2.59	-	-	-	-	
DHPP7-16-3 SPT#2	8.5-10.0	SM	11.0	9.9	79.1	0.0	0.0	0.0	NA	NP	-	-	3.3	-	2.58	-	-	-	-	
DHPP7-16-4 SPT#1	4.0-5.5	s(CL)	34.8	18.1	47.1	0.0	0.0	0.0	29.6	15.1	-	-	6.5	-	2.65	-	-	-	-	
DHPP7-16-5 SPT #1	3.0-4.5	SM	12.7	5.5	81.8	0.0	0.0	0.0	NA	NP	-	-	2.8	-	2.61	-	-	-	-	
DHPP7-16-5 SPT #2	8.0-9.5	SM	19.9	13.5	66.6	0.0	0.0	0.0	NA	NP	-	-	7.5	-	2.64	-	-	-	-	

NOTE: Numbers in parentheses are metric equivalents of numbers directly above

## SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Pumping Plant 7

Page 2 of 3

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
SAMPLE NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.075mm) to #4 (4.75mm)	GRAVEL #4 (4.75mm) to #10 (2.0mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY -pcf	FULL MOISTURE CONTENT - %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.075mm															
DHPP7-16-6 SPT #1	3.0-4.5	SM	20.3	8.5	71.2	0.0	0.0	0.0	NA	NP	-	-	4.6	-	2.60	-	-	-	-
DHPP7-16-6 SPT #2	5.5-7.0	SM	15.0	7.9	77.1	0.0	0.0	0.0	NA	NP	-	-	4.1	-	2.60	-	-	-	-
DHPP7-16-6 SPT #3	10.5-12.0	SM	13.8	11.7	74.5	0.0	0.0	0.0	NA	NP	-	-	5.3	-	2.66	-	-	-	-
DHPP7-16-6 SPT #4	13.0-14.5	SM	15.2	13.3	71.5	0.0	0.0	0.0	NA	NP	-	-	6.4	-	2.63	-	-	-	-
DHPP7-16-6 SPT #5	18.0-19.5	SM	15.5	11.3	73.2	0.0	0.0	0.0	NA	NP	-	-	8.6	-	2.63	-	-	-	-
DHPP7-16-7 SPT #1	3.0-4.5	s(CL)	33.2	22.6	44.2	0.0	0.0	0.0	30.0	15.5	-	-	7.9	-	2.62	-	-	-	-
DHPP7-16-8 SPT #1	3.0-4.5	SM	21.4	17.1	61.5	0.0	0.0	0.0	NA	NP	-	-	4.7	-	2.54	-	-	-	-
DHPP7-16-9 SPT #1	3.0-4.5	s(CL)	28.1	24.8	47.1	0.0	0.0	0.0	28.3	14.7	-	-	4.9	-	2.61	-	-	-	-
DHPP7-16-9 SPT #2	8.0-9.5	SM	14.1	17.2	68.7	0.0	0.0	0.0	NA	NP	-	-	6.3	-	2.58	-	-	-	-
DHPP7-16-10 SPT #1	3.0-4.5	SC-SM	23.0	13.3	63.7	0.0	0.0	0.0	24.4	6.6	-	-	4.7	-	2.63	-	-	-	-

NOTE: Numbers in parentheses are metric equivalents of numbers directly above

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Pumping Plant 7

Page 3 of 3

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
SAMPLE NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.075mm) to #4 (4.75mm)	GRAVEL #4 (4.75mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - pcf	FULL MOISTURE CONTENT - %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.075mm															
DHPP7-16-11 SPT #1	3.0-4.5	SC-SM	25.3	14.2	60.5	0.0	0.0	0.0	23.5	5.9	-	-	5.1	-	2.63	-	-	-	-
DHPP7-16-11 SPT #2	8.0-9.5	SC-SM	22.9	22.8	54.3	0.0	0.0	0.0	24.7	6.3	-	-	5.6	-	2.63	-	-	-	-
DHPP7-16-11 SPT #3	15.5-17.4	CL	51.2	36.1	12.7	0.0	0.0	0.0	40.1	19.9	16.2	-	16.2	-	2.67	-	-	-	-
TPPP7-16-6	6.0	s(CL)	29.2	24.5	46.3	0.0	0.0	0.0	25.4	11.3	-	103.2	6.9	-	2.66	112.5	14.5	560	91.7
TPPP7-16-8	7.0	s(CL)	38.3	30.2	31.5	0.0	0.0	0.0	34.7	20.5	-	113.8	9.7	-	2.69	106.2	17.7	550	107.2

NOTE: Numbers in parentheses are metric equivalents of numbers directly above

# **APPENDIX 3**

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# Navajo Gallup Water Supply Project

## San Juan Lateral Pumping Plant 7 Drill Core Photos















NGWSP  
PUMPING PLANT 7  
DHPP7-16-3  
0.0-3.5  
7-16-15



NGWSP  
PUMPING PLANT 7  
DHPP7-16-3  
3.5-5.0  
7-16-15





































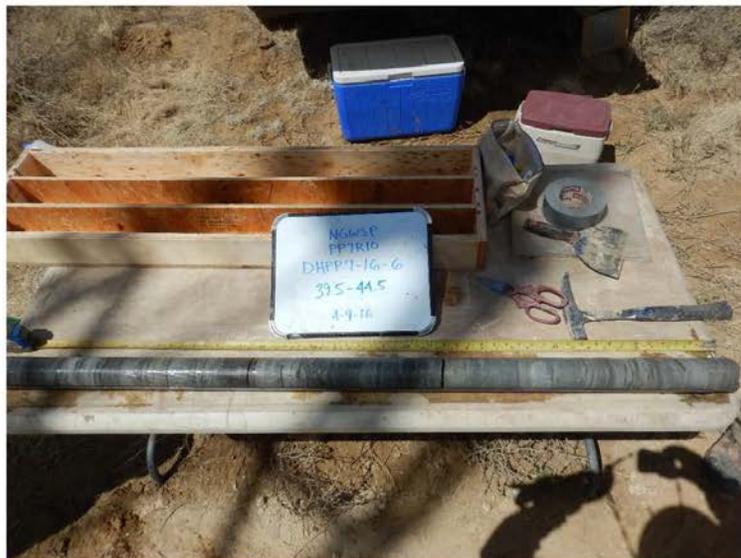






















































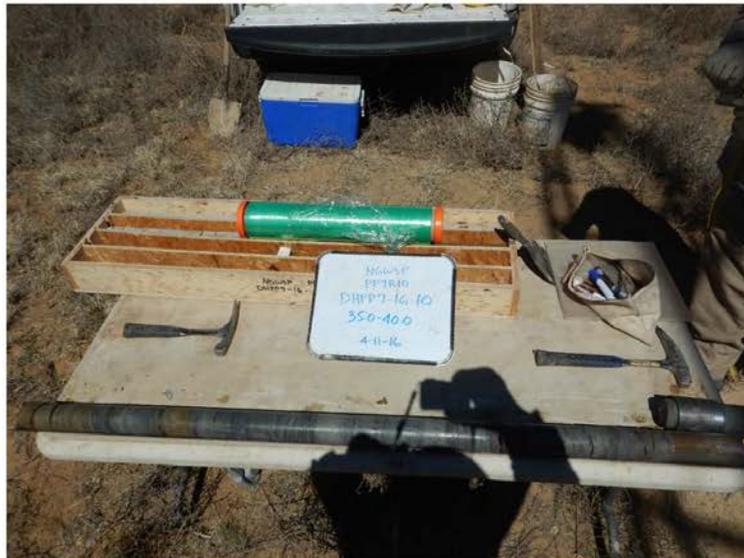
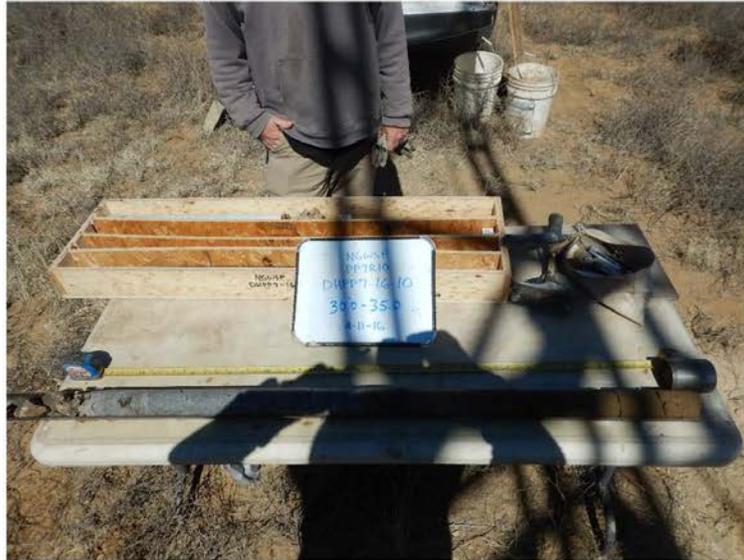






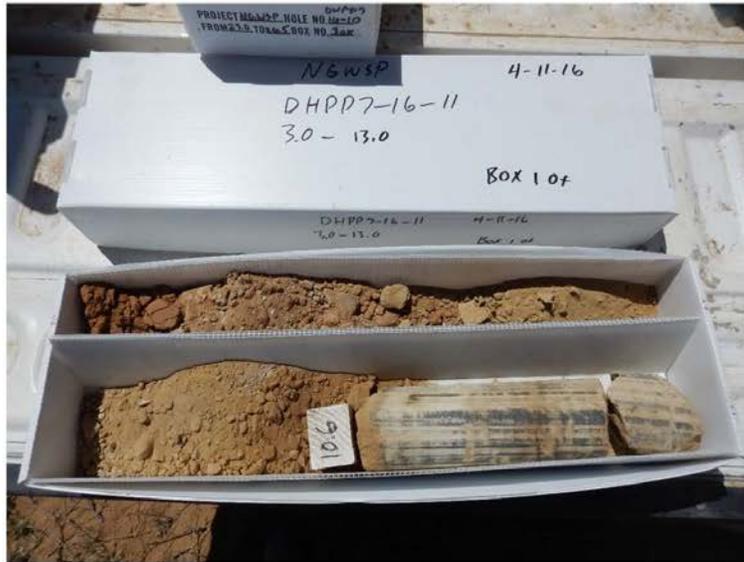


















# Navajo Gallup Water Supply Project

## San Juan Lateral Pumping Plant 7 Test Pit Photos











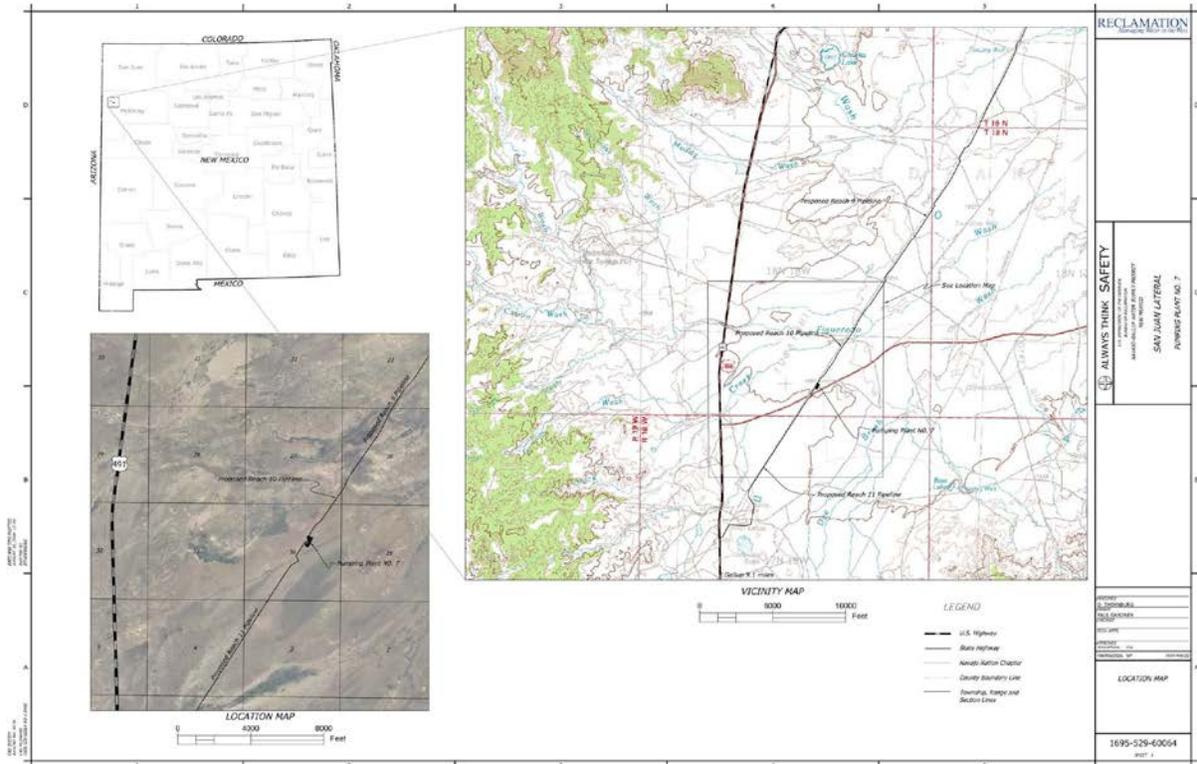
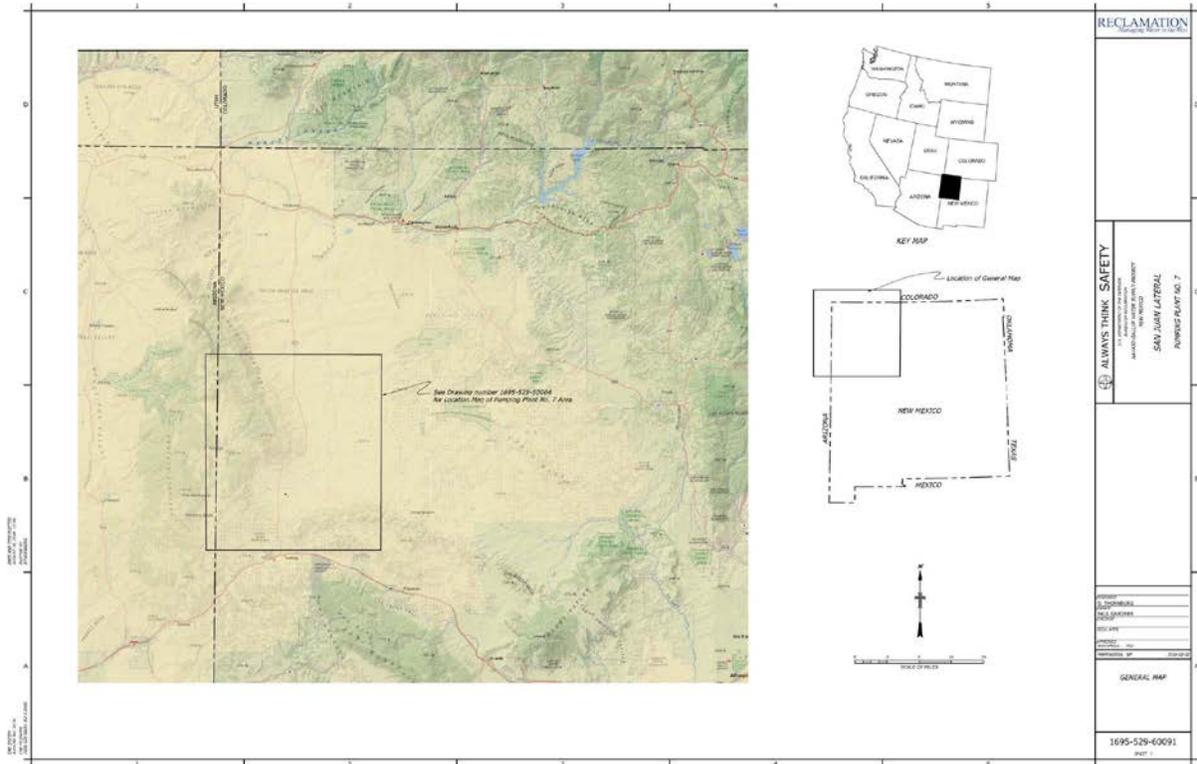


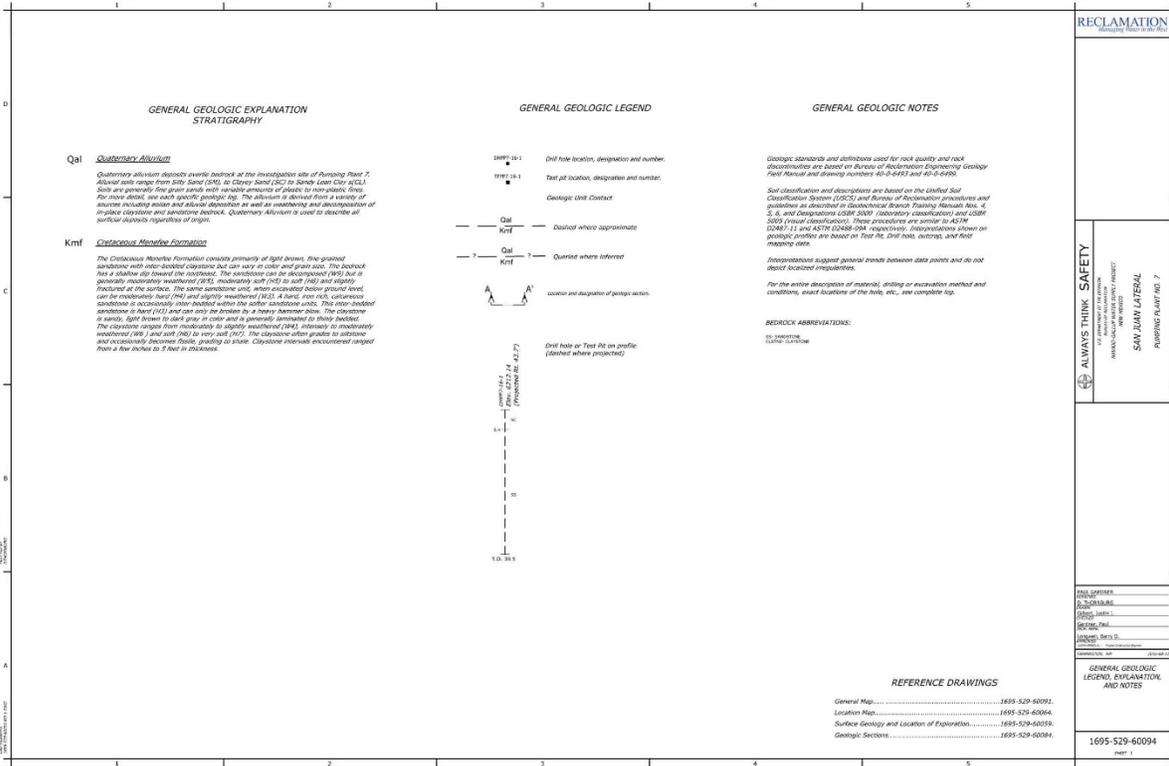




# **APPENDIX 4**

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**GENERAL GEOLOGIC EXPLANATION  
STRATIGRAPHY**

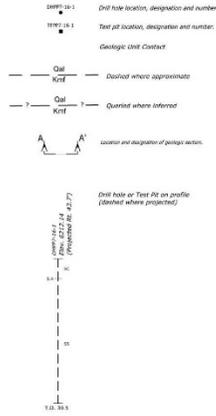
**Qal Quaternary Alluvium**

Quaternary alluvium deposits overlie bedrock at the investigation site of Pumping Plant 7. Alluvium extends from the River (R) to the River (R) and from the River (R) to the River (R). It is generally fine grained with variable amounts of clastic to non-clastic. For more detail, see each specific geologic log. The alluvium is divided into a variety of facies including siltstone and silty sandstone as well as sandstone and conglomerate of in-place claststone and sandstone facies. Quaternary Alluvium is used to describe all surficial deposits regardless of origin.

**Kmf Cretaceous Manley Formation**

The Cretaceous Manley Formation consists primarily of light brown, fine-grained sandstone with inter-bedded claystones but can vary in color and grain size. The bedrock has a shallow dip toward the northeast. The sandstone can be micaceous (MS) but is generally moderately micaceous (MS), moderately soft (S) to soft (SO) and slightly fractured at the surface. The same sandstone and, when excavated below ground level, can be micaceous (MS) and slightly micaceous (MS). A hard, non-MS, calcareous sandstone is occasionally inter-bedded within the softer sandstone units. This inter-bedded sandstone is hard (H) and can only be broken by a heavy hammer blow. The claystone is sandy, light brown to dark gray in color and is generally laminated to thinly bedded. The claystone ranges from moderate to slightly micaceous (MS), intensely micaceous (MS) and soft (SO) to very soft (VS). The claystone often grades to siltstone and occasionally, becomes silty, grading to silty. Claystone thickness encountered ranged from a few inches to 3 feet in thickness.

**GENERAL GEOLOGIC LEGEND**



**GENERAL GEOLOGIC NOTES**

Geologic standards and definitions used for rock quality and rock observations are based on Bureau of Reclamation Engineering Geology Field Manual and drawing numbers 40-9-6193 and 40-9-6195. Soil classification and descriptions are based on the Unified Soil Classification System (USCS) and Bureau of Reclamation procedures and guidelines as described in Geotechnical Branch Training Manual No. 4, 5, 6, and Designation USBR 500 (laboratory classification) and USBR 5000 (field classification). These procedures are similar to ASTM D2487-11 and ASTM D2488-09A, respectively. Interpretations shown on geologic profiles are based on Test Pit, Drill logs, outcrops, and their mapping data.

Interpretations suggest general trends between data points and do not denote localized irregularities. For the entire description of methods, drilling or excavation method and conditions, exact locations of the holes, etc., see complete log.

**BEDROCK ABBREVIATIONS:**

MS MICACEOUS  
S SOFT

**REFERENCE DRAWINGS**

General Map.....	1695-529-60091
Location Map.....	1695-529-60084
Surface Geology and Location of Exploration.....	1695-529-60098
Geologic Sections.....	1695-529-60084

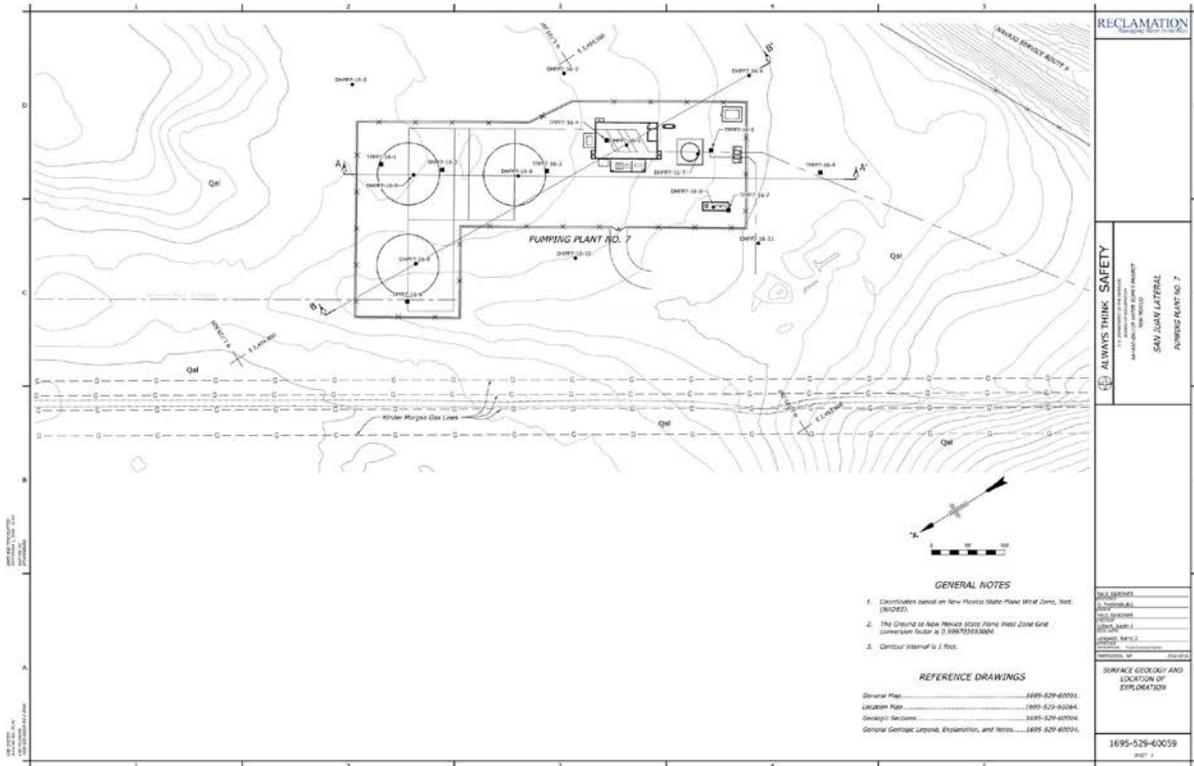
**RECLAMATION**  
BUREAU OF RECLAMATION  
1695-529-60094

**ALWAYS THINK SAFETY**  
SAFETY IS THE MOST IMPORTANT PART OF ANY PROJECT.  
SAFETY IS EVERYONE'S RESPONSIBILITY.  
SAFETY IS THE WAY TO SUCCESS.

**SAFETY**  
SAFETY IS EVERYONE'S RESPONSIBILITY.  
SAFETY IS THE WAY TO SUCCESS.

**GENERAL GEOLOGIC LEGEND, EXPLANATION, AND NOTES**

1695-529-60094  
page 1



**GENERAL NOTES**

1. Coordinates based on New Florida State Plane 1814 Zone, NAD 83 (NAD83).
2. The Ground to Air Water Table (AWT) and Water Table (WT) are shown on the adjacent sheet.
3. Contour Interval is 1 Foot.

**REFERENCE DRAWINGS**

General Plan ..... 1695-529-6059L  
 Location Plan ..... 1695-529-6058A  
 Geologic Sections ..... 1695-529-6070A  
 Geologic General Layout, Explanation, and Notes ..... 1695-529-6059L

**RECLAMATION**  
 Florida Department of Transportation  
 1695-529-6059L

**SAFETY**  
 ALWAYS THINK SAFETY  
 SAFETY IS EVERYONE'S RESPONSIBILITY

**SAFETY LATERAL**  
 PUMPING PLANT NO. 7

DESIGNED BY	
CHECKED BY	
DATE	
PROJECT NO.	
SCALE	
DATE	
BY	
DATE	

**SURFACE GEOLOGY AND LOCATION OF EXPLORATION**

1695-529-6059  
 sheet 1

**PART 1**





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**SECTION 53 60 00**  
**PUMPING PLANT 7 – GEOTECHNICAL DESIGN**

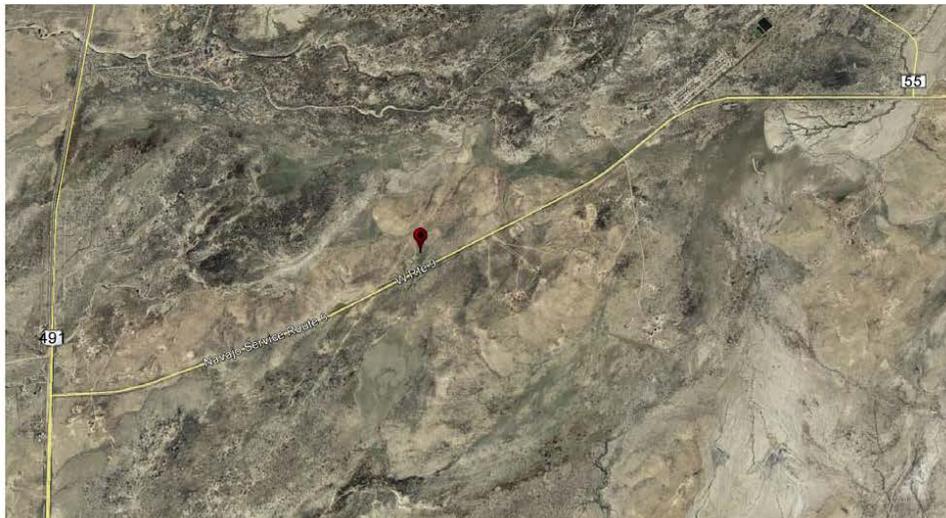
# RECLAMATION

*Managing Water in the West*

Technical Memorandum No. ZN-8314-6

## Pumping Plant 7 – Geotechnical Design

Navajo-Gallup Water Supply Project  
San Juan Lateral, New Mexico



U.S. Department of the Interior  
Bureau of Reclamation  
Technical Service Center  
Denver, Colorado

September 2018

**CONTROLLED**

## **Mission Statements**

The mission of the Department of the Interior is to protect and manage the Nation's natural resources and cultural heritage; provide scientific and other information about those resources; and honor its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

**BUREAU OF RECLAMATION**  
**Technical Service Center, Denver, Colorado**  
**Geotechnical Engineering Group 4**

**Technical Memorandum No. ZN-8314-6**

**Pumping Plant 7 - Geotechnical Design**  
**Navajo-Gallup Water Supply Project**  
**San Juan Lateral, New Mexico**

Caleb Rudkin P.E.

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Geotechnical Engineering Group 3, 86-68313

Dennis Hanneman, P.E. 9/6/2018

Peer Review: Dennis Hanneman, P.E.  
Geotechnical Engineering Group 1, 86-68311

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

## Technical Memorandum No. ZN-8314-6 Pumping Plant 7 Foundation Recommendations

### I. Executive Summary

This report documents geotechnical aspects of design associated with construction of Pumping Plant 7 and its appurtenant structures. Geotechnical design considerations include mitigation of heave associated with expansive materials, soil settlement associated with new loadings, and mitigation of corrosion caused by soil/concrete interaction.

#### Expansive Soils/Bedrock

Subsurface investigations were conducted to identify and evaluate potentially expansive materials at the site. Investigations showed bedrock to consist primarily of sandstone with thin interbeds of potentially expansive claystone. However, the claystone interbeds are typically thin enough and at great enough depth that they are unlikely to contribute to detrimental heave at the base of the structure foundations.

The alluvial materials have slight potential for expansion. Materials near the ground surface would be particularly at-risk since they are more likely to be dry, giving them ability to retain more moisture and thus resulting in more expansion. However, most of this material is likely to be removed during construction, since the alluvium is typically 3 to 5 feet deep. In areas where the alluvium extends deeper, it may be necessary to remove the material to mitigate potential heave, particularly if the material is found to have a high content of fines and clay.

### II. Project Description

Pumping Plant 7 is part of the Navajo Gallup Water Supply Project. Construction of infrastructure will allow water to be removed from the San Juan River system, providing a reliable water source to populations within the Navajo Nation, the Jicarilla Apache Nation, and the city of Gallup, New Mexico. The Pumping Plant 7 site is located on a mesa along Navajo Service Route 9, and serves as the transition location from Reach 10 to Reach 11.

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Pumping Plant 7 – Geotechnical Design**

The proposed pumping plant building is approximately 73 feet long by 46 feet wide. The finished floors are at elevation 6215.0. The structure includes a mat foundation (1-foot-thick) with thickened edges around the perimeter (3.5 feet thick) that serve as a spread footing. The pipeline connects to four vertical pump cans, which each extend to 18.8 feet below the top of the slab. Concrete encasements surround the steel pump cans, creating a closed system that reduces the likelihood of water being able to leak into the surrounding foundation materials.

The air chamber room is connected to the pumping plant building. It has a footprint that is approximately 61 feet long by 50 feet wide. It is connected to the pumping plant building, but is offset by 13 feet in the southeast direction. It also includes a mat foundation (1.5 feet thick) with thickened edges (3.5 feet thick). The air chamber equipment is connected to the pipeline at a depth of 8.5 feet below the top of the slab, and all subsurface lines are encased in concrete, providing protection against seepage into the surrounding foundation materials.

The proposed water storage tanks each have a capacity of 1.5-million gallons. The inside diameter (I.D.) of each tank is 105-feet, and the height is 28 feet. The foundation of the tanks will depend on whether concrete or steel tanks are selected for construction. However, ring foundations are presented in the design drawings. Only a single storage tank is to be installed during initial construction; however, space will be provided to accommodate installation of a second tank in the future.

Several vaults and manholes, to be constructed out of precast concrete, will also be constructed below grade on the site to provide access to the pipe. The proposed locations of all structures and construction items are shown on Figure 1.

It is noted that there is no chemical building on the site, as there is at the site of pumping plant 4. The design of the sites is extremely similar, but this is one of the key differences between the sites.

### **III. Geology and Subsurface Conditions**

The following sections (IIIA, III.B, and III.C) were copied verbatim from the Geologic Design Data Report for San Juan Lateral, Pumping Plant 7 [1].

#### **A. Regional Geology**

The San Juan Basin is a broad basin that is surrounded by many mountain ranges with distinct geologies including the Chuska Mountains, the La Plata Mtns, the San Juan Mtns, the San Pedro Mtns, the Zuni Mtns. and Mt. Taylor.

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Characterized by plateaus, mesas and dry-wash canyons presently being eroded in an arid climate, the San Juan Basin is a structural depression that contains Quaternary and Tertiary alluvium, resting on rocks of Tertiary and Cretaceous age which crop out around the margins of the basin. The NGWSP San Juan Lateral is located on the east slope of the Chuska Mountains, near the southwestern margin of the basin north of Gallup, New Mexico. The eastern slope of the Chuska Mountains varies from landslides and pediments to many types of alluvium and mudflats. Bedrock units which outcrop along this portion of the San Juan Lateral are the Cretaceous Menefee Formation. The bedrock is typically covered on the surface by varying amounts of surficial deposits mapped on the surface as Quaternary Alluvium. The Menefee Formation sandstone generally forms cap rock on the hill tops and the softer claystone and shale units form the lower slopes on the hills.

**B. Site Geology**

Pumping Plant 7 is located on a broad, low-lying alluvial valley known as Tohatchi Flats. This depositional environment is primarily floodplain. The high mountains and low-relief channels seasonal runoff to small drainages and larger washes creating a setting that facilitates flooding and scour. Fine grain sands with clays and silts and sandstone are encountered at the pumping plant foundation.

**C. Stratigraphy**

The geologic units encountered at the Pumping Plant 7 footprint consists of surficial alluvium on bedrock of sandstone and claystone. The alluvium varies in depth and bedrock is generally found within 6 feet of the ground surface. Sandstone is the predominant bedrock unit with occasional inter-bedded claystone.

**1. Surficial Deposits****a. Quaternary Alluvium (Qal)**

Quaternary alluvium deposits overlie bedrock at the investigation site of Pumping Plant 7. Alluvial soils range from Silty Sand (SM), Silty Clayey Sand (SC-SM), to Clayey Sand (SC) and Sandy Lean Clay s(CL). Soils are generally fine grain sands with variable amounts of plastic to non-plastic fines. For more detail, see each specific geologic log. The alluvium is derived from a variety of sources including eolian and alluvial deposition as well as weathering and decomposition of in-place sandstone and claystone bedrock. Quaternary Alluvium is used to describe all surficial deposits regardless of origin.

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**2. Bedrock****a. Cretaceous Menefee Formation (Kmf)**

The Cretaceous Menefee Formation consists primarily of light brown, fine-grained sandstone with interbedded claystone, shale and siltstone but can vary in color and grain size. The bedrock locally has a shallow dip toward the northeast. The sandstone can be decomposed (W9) but is generally moderately weathered (W5), moderately soft (H5) to soft (H6) and slightly fractured at the surface. The same sandstone unit, when excavated below ground level, can be moderately hard (H4) and slightly weathered (W3). A hard, iron rich, calcareous sandstone is occasionally inter-bedded within the softer sandstone units. This inter-bedded sandstone is hard (H3) and can only be broken by a heavy hammer blow. The claystone is sandy, light brown to dark gray in color and is generally laminated to thinly bedded. The claystone ranges from moderately to slightly weathered (W4) to intensely to moderately weathered (W6) and soft (H6) to very soft (H7). The claystone often grades to siltstone and occasionally becomes fissile, grading to shale. Claystone intervals encountered ranged from a few inches to 2 feet in thickness.

**IV. Field Explorations**

Geologic investigations (Figure 2) were performed at the site by Reclamation's Four Corners Construction Office (FCCO) geology group and Reclamation's Upper Colorado and Great Plains drill crews. The investigations included eleven (11) exploratory borings (DHSTR7-16-1 through -7) performed in April and July of 2016. The exploratory borings included testing and sampling via Standard Penetration Test (SPT) methods; blows-per-foot were counted at 5-foot testing intervals, and samples were obtained using split-soon sampler. These samples were sent to the Four Corners Construction Office (FCCO) laboratory for testing.

Borings typically encountered alluvial soils within the top 3 to 10 feet of each hole; material samples were predominately classified as clayey sand (SC), although several samples classified as silty sand (SM). Sandstone was encountered below the alluvial materials, with an occasional interbedded layer of claystone. Upon encountering claystone, the California Modified Sampler was used with brass liners within the split-spoon sampler to obtain "less-disturbed" samples; these samples were obtained for testing of consolidation and swell potential. A total of seven brass liner samples were obtained. These samples were sent to Reclamation's Concrete, Geotechnical, and Structural Laboratory (CGSL) in Denver, where swell and consolidation testing could be performed via one-dimensional consolidometers.

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Eight (8) test pits were also dug in June of 2016. Two in-place density tests were performed via sand cone method within these test pits; sand cone tests were not performed when sandstone was encountered above within about 5 feet of the ground surface. Samples from the two in-place density tests were also sent to the FCCO laboratory for testing.

Additional exploratory borings were performed along the adjacent Reaches 10 and 11. However, these borings are not discussed within this report. Additional information on these borings is available in the San Juan Lateral Block 9-11 - Geologic Design Data Report [2].

**A. Field Test Results****1. SPT Testing**

SPT tests were typically performed at depths of 4-5 feet and 9-10 feet, and occasionally at greater depths, as presented in Table 2. Blow-counts within the upper alluvial material ranged from 14 to greater than 50. Blow-counts within the sandstone were greater than 50, except for a single test which resulted in a lower blow count of 27. The distribution of blow-counts is summarized in Table 1.

**Table 1. – Distribution of blow-counts from SPT testing within alluvial material**

Number of blows	# of occurrences	Percentage
<b>Alluvial materials</b>		
0-10	0	0.0%
11-20	4	33.3%
21-30	2	16.7%
31-40	3	25.0%
41-50	0	0.0%
>50	3	25.0%
<b>Sandstone</b>		
0-10	0	0.0%
11-20	0	0.0%
21-30	1	12.5%
31-40	0	0.0%
41-50	0	0.0%
>50	7	87.5%

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Table 2. – SPT testing at Pumping Plant 7 site

Hole (location)	Depth (feet)	USCS	Blows per 0.5 feet*
DHPP7-16-1 (Pumping Plant)	3.5-5.0	SC-SM	6/17/46
	8.5-9.5	N/A*	NA/28/50
DHPP7-16-5 (Tank)	3.0-4.5	SM	13/15/18
	8.0-9.5	SM	16/49/50
	37.0-38.0	N/A*	NA/50/NA
DHPP7-16-6 (Tank)	3.0-4.5	SM	10/15/19
	5.5-7.0	SM	13/34/50
	10.5-12.0	SM	33/50/NA
	13.0-14.5	SM	37/50/NA
	18.0-19.5	SM	34/50/NA
DHPP7-16-7 (Air Chamber)	3.0-4.5	s(CL)	6/8/14
DHPP7-16-8	3.0-4.5	SM	12/13/14
DHPP7-16-9 (Tank)	3.0-4.5	s(CL)	5/7/7
	8.0-9.5	SM	28/45/50
DHPP7-16-10 (Site Investigation)	3.0-4.5	SC-SM	8/10/9
DHPP7-16-11 (Site Investigation)	3.0-4.5	SC-SM	6/9/8
	8.0-9.5	SC-SM	18/35/50
	40.0-41.0	N/A**	NA/50/NA

\* includes blows for 0.5-foot seating interval, and two subsequent 0.5-foot intervals

\*\*sample was obtained via California sampler; physical properties testing was not performed.

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Pumping Plant 7 – Geotechnical Design****2. In-place Density Testing**

In-place density tests were performed via the sand cone method within the alluvial soils in each of TPPP7-16-6 and TPPP7-16-8. These tests were performed at depths of 6 and 7 feet, respectively. An additional piece of data was obtained from a test performed on the site as part of investigations for design of Reach 10. Results are presented in Table 3.

**Table 3. – Results of in-place density tests**

Test Pit Number	Depth (feet)	USCS	w (%)	In-place Density (lbf/ft <sup>3</sup> )	D-value (%)	Max Dry Density (lbf/ft <sup>3</sup> )	Opti. w (%)
TPPP7-16-6	6.0	s(CL)	6.9	103.2	91.7	112.5	14.5
TPPP7-16-8	7.0	s(CL)	9.7	113.8	107.2	106.2	17.7
<b>From Reach 10*</b>							
TPR10-15-4	7	SM	6.0	97.9	88.2	111.0	15.6

**3. Geologic Mapping**

The exploration location map, geologic cross sections and geologic logs for exploratory borings and test pits were developed from the findings of the geologic exploratory program. They are available in the Geologic Design Data Report for San Juan Lateral, Pumping Plant 7 [1].

**4. Groundwater**

Groundwater was encountered in 4 of the 11 holes. However, since groundwater was not encountered at depths of less than 29.8 feet, it is considered to be highly unlikely to impact construction. If groundwater is encountered during construction, unwatering and/or dewatering measures will be necessary.

**V. Laboratory Testing**

Samples were sent to both the FCCO laboratory in Farmington and the CGSL laboratory in Denver, as described in the Field Explorations section above. All tests were performed in accordance with American Society for Testing and Materials (ASTM) procedures and/or United States Bureau of Reclamation (USBR) procedures.

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**A. Swell and Consolidation Testing**

The brass liner samples were sent to Denver in case one-dimensional (1-D) swell/consolidation testing was requested. However, after reviewing the samples and the drill logs, it was decided that no consolidometer testing was necessary. The samples were found to contain sandstone materials and did not appear to contain plastic fines (no smearing, etc.). Additionally, the samples were from significant depths, and would therefore provide only marginally useful information even if they had contained expansive materials.

**B. Physical Properties Testing**

Physical properties testing was performed on all samples sent to the FCCO laboratory. No additional physical properties testing was performed by Reclamation's CGSL laboratory in Denver.

**1. FCCO Laboratory**

The FCCO laboratory performed the following physical properties tests:

- Moisture Content and Dry Density Determination
- Standard Test Method for Particle-Size Analysis of Soils
- Standard Test Methods for Liquid Limit (LL), Plastic Limit (PL) and Plasticity Index (PI) of Soils

Testing was performed on sixteen samples obtained from the SPT drilling program, two samples obtained from test pits on the site (during sand cone density tests). Data was also available from an additional sample obtained from the site during investigations for reaches 9 through 11 ("Block 9-11") [2]. Tables 4 and 5 provide a summary of the results from physical properties testing. The Geologic Design Data Report for San Juan Lateral, Pumping Plant 7 [1] provides additional details on the materials encountered.

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**Table 4. – Summary of Physical Properties Testing from SPT samples**

Sample # DHPP__	SPT #	Depth (ft)	USCS	Clay*	Silt*	Sand*	Gravel*	Liq. Limit (%)	Plast. Index (%)
7-16-1 (pumping plant)	#1	3.5 – 5.0	SC-SM	24.4	14.5	61.1	0	22.2	4.5
7-16-2	#1	4.0 – 5.5	SC-SM	22.0	6.8	71.2	0	24.0	6.2
7-16-3	#1	3.5 – 5.0	SM	18.9	8.1	73.0	0	NA	NP
	#2	8.5 – 10.0	SM	11.0	9.9	79.1	0	NA	NP
7-16-4	#1	4.0 – 5.5	s(CL)	34.8	18.1	47.1	0	29.6	15.1
7-16-5 (tank)	#1	3.0 – 4.5	SM	12.7	5.5	81.8	0	NA	NP
	#2	8.0 – 9.5	SM	19.9	13.5	66.6	0	NA	NP
7-16-6 (tank)	#1	3.0 – 4.5	SM	20.3	8.5	71.2	0	NA	NP
	#2	5.5 – 7.0	SM	15.0	7.9	77.1	0	NA	NP
	#3	10.5 -12.0	SM	13.8	11.7	74.5	0	NA	NP
	#4	13.0 -14.5	SM	15.2	13.3	71.5	0	NA	NP
	#5	18.0 -19.5	SM	15.5	11.3	73.2	0	NA	NP
7-16-7	#1	3.0 – 4.5	S(CL)	33.2	22.6	44.2	0	30.0	15.5
7-16-8	#1	3.0 – 4.5	SM	21.4	17.1	61.5	0	NA	NP
7-16-9 (tank)	#1	3.0 – 4.5	S(CL)	28.1	24.8	47.1	0	28.3	14.7
	#2	8.0 – 9.5	SM	14.1	17.2	68.7	0	NA	NP
7-16-10	#1	3.0 – 4.5	SC-SM	23.0	13.3	63.7	0	24.4	6.6
7-16-11	#1	3.0 – 4.5	SC-SM	25.3	14.2	60.5	0	23.5	5.9
	#2	8.0 – 9.5	SC-SM	22.9	22.8	54.3	0	24.7	6.3
	*	15.5 – 17.4	SC-SM	51.2	36.1	12.7	0	40.1	19.9

\* Sample taken from drill cuttings

Samples with a plasticity index (PI) greater than 10 shown in grey

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**Table 5. – Summary of Physical Properties Testing from Test Pit samples**

Sample #	Depth (ft)	USCS	Clay	Silt	Sand	Gravel	LL	PI
<b>Pumping Plant 7 Test Pits</b>								
TPPP7-16-6-	6.0	S(CL)	29.2	24.5	46.3	0.0	25.4	11.3
TPPP7-16-8	7.0	S(CL)	38.3	30.2	31.5	0.0	34.7	20.5
<b>Reach 10 Test Pits</b>								
TPR10-15-4	7.0	SM	16.8	5.6	77.6	0.0	27.2	1.0

Of the nineteen samples tested, five were classified to be fine-grained (more than 50 percent fines), with one of these samples being classified as a lean clay (CL), and the other four being classified as a sandy lean clay, s(CL). The liquid limit of the fine-grained samples ranged from 25 to 40 with an average of 31.6. The plasticity index ranged from 11 to 20.5, with an average of 16.6.

Of the coarse-grained samples, ten were classified as a silty sand (SM), while four were classified as borderline clayey-sand to silty sand (SC-SM).

### C. Corrosion Testing

The pumping plant structure is planned to extend nearly 20 feet below the ground surface. Materials at this depth will therefore be in contact with the concrete structures. Corrosivity testing was performed on two samples from the site at depths within 20 feet of the ground surface. The first sample was taken from a depth of roughly 5 feet below the ground surface within test pit TPPP7-16-3 (roughly halfway between the edge of storage tank T2 and the edge of the pumping plant building). The second sample was taken from a depth of roughly 3 feet below the ground surface within test pit TPPP7-16-7 (roughly 50 feet west of the southwest corner of the air chamber building).

Testing was performed by Reclamation's Materials and Corrosion Laboratory. A summary of test results is presented in Table 6.

**Table 6. – Summary of Corrosion Testing**

Sample #	Test Pit	Depth (feet)	Chloride Concentration (mg/L)	Sulfate Concentration (mg/L)	pH
1	TPPP7-16-3	5.0	13	50	6.7
2	TPPP7-16-7	3.0	334	206	6.6

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From these results, the following conclusions were made:

- pH for both soil samples were in the “neutral” range ( $5.5 < \text{pH} < 10$ )
- Chloride concentrations fall in the “low” range ( $< 100$  ppm) for one sample and in the “moderate” range ( $100 \text{ ppm} < x < 500 \text{ ppm}$ ) for the other soil sample
- Sulfate concentrations fall in the “low” range for both samples ( $< 1000$ )

The results indicate the need for special considerations on this project pertaining to corrosion of metals and chloride attack on concrete. Due to the moderate chloride and sulfate concentrations observed within the area, it is advised that all concrete structures use Type V or Type HS (high sulfate) cement.

## **VI. Design**

### **A. Accommodations for Expansive Materials**

#### **1. Alluvium**

Alluvium at the site is typically 3 to 5 feet deep but was found to be as deep as 10.5 feet. Although a majority of samples of alluvial materials were classified as sandy silt (SM), some samples were found to have a clay content as high as 35 percent. Plasticity indices ranged from 0 to 20.5 with an average of 7.7. This average value indicates low potential for expansion, per guidance by Holtz and Kovacs [3].

To further investigate the potential for expansion, the index properties were compared to samples from from the nearby Tohlakai site, where expansive potential is a known issue. Soil and bedrock samples from Tohlokai were tested to exhibit between 1 percent and 10 percent swell [4], with a moderate to good correlation between plasticity index and percent swell. Of three samples with a PI ranging from 20 to 30, 1-dimensional consolidometer testing for swell potential resulted in percent swell results of 1.3 percent, 1.1 percent, and 3.8 percent. No tests were performed on soils with PI values of less than 20.

Based on the guidance by Holtz and Kovacs as well as the comparison to data from Tohlakai, the alluvium is believed to have low potential for expansion, although it is possible that isolated areas could have medium/moderate potential for expansion. This may be particularly true if the material is near the ground surface; such materials would be more likely to be dry in their existing state, and

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thus more likely to increase in moisture content after construction, resulting in expansion and possible heave.

**2. Bedrock**

Drill logs show that below a thin layer of alluvium, the site consists primarily of sandstone with occasional thin interbeds of claystone. Investigations indicate that expansive claystone is only at depths that would be unlikely to impact the overlying structures during the life of the structure. Expansive claystone was only encountered at depths within 30 feet of the ground surface in a single drill hole; a layer roughly 2 feet thick was found in DHPP7-16-11 between depths of 15 and 17 feet below the ground surface. DHPP7-16-11 is near the high point of the site and is more than 100 feet away from the pumping plant and air chamber building.

The possibility exists that additional claystone layers or seams are present at shallower depths across the site. If the foundation and floor elements are placed on or close to expansive claystone bedrock, they could experience foundation movement (heave) that could result in significant damage.

**a. Heave Analyses**

A heave analysis was performed to investigate the potential for differential movement caused by an interbedded claystone layer. The evaluation involved dividing the soil and bedrock profiles into layers and estimating the potential heave characteristics of each layer. It was assumed that no swelling occurs in the placed structural fill materials, in the underlying alluvium, or in the sandstone below the claystone layer. All swelling was assumed to occur at a depth of 15 feet below the ground surface, within a two-foot thick layer of claystone located between the alluvium and sandstone layers (as was observed in DHPP7-16-11).

Swell test results were unavailable for the site since no testable samples had been obtained; brass liners were unable to target the thin layer of claystone, but rather captured primarily sandstone materials that contained a minor amount of fines. Instead a swell potential of 8 percent was assumed, based on the average swell potential observed on tests of samples from the nearby pumping plant 4 site (roughly 30 miles to the north).

The evaluation, and these assumptions, are summarized in the equation below.

$$S_T = 12 * S_A * [(T_1 * S_1) + (T_2 * S_2) + (T_3 * S_3) + (T_4 * S_4)]$$

where variables are defined as presented in Table 7:

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**Table 7. – values used in heave analysis**

Layer	Symbol	Description	Value
Layer 1: Structural Fill	T <sub>1</sub>	Thickness of layer 1	14 feet
	S <sub>1</sub>	Percent swell of layer 1	0%
Layer 2: Alluvium	T <sub>2</sub>	Thickness of layer 2	1 feet
	S <sub>2</sub>	Percent swell of layer 2	0%
Layer 3: Claystone	T <sub>3</sub>	Thickness of layer 3	2 foot
	S <sub>3</sub>	Percent swell of layer 3	8%
Layer 4: Sandstone	T <sub>4</sub>	Thickness of layer 4	3 foot
	S <sub>4</sub>	Percent swell of layer 4	0%

and:

S<sub>F</sub> = swell factor representing actual heave realized at surface, assume 0.7

S<sub>T</sub> = total swell (in inches) at ground surface

The resulting total swell, S<sub>T</sub>, was calculated to be 1.3 inches. This value exceeds the design tolerance of 1 inch of movement; structures have been designed to withstand 1 inch of movement. However, this analysis assumes all stresses are transferred vertically. Actual vertical heave will be further reduced as stresses are transferred both vertically and laterally, also minimizing the likelihood of heave resulting in differential movements. The swell calculations are considered to be somewhat conservative and close enough to the design tolerance to be considered acceptable.

### 3. Mitigation

It should be emphasized that there is risk involved in the construction of infrastructure in an area where expansive materials are present at a shallow depth. If claystone or other potentially expansive materials are encountered during construction, the design team should be contacted. A likely remedy would be to overexcavate the materials, particularly since any expansive materials in the area will likely occur in small layers or lenses.

If the alluvial materials are found to exhibit clay-like behavior (i.e. tested to have a plasticity index greater than 10), it may be necessary to remove the material down to sandstone. The area could then be built back up to grade using non-expansive materials. If non-expansive materials are unavailable from the site, the removed materials may be moisture conditioned to optimum moisture content (or slightly higher) to mitigate the potential for expansion.

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## B. Material Parameters for Design

Material parameters were provided to the design team for use in structural analyses, including bearing capacity analyses, thrust block design, settlement calculations, quantity calculations, etc. However, since shear strength tests were not performed in a laboratory setting, strength parameters were provided based on material correlations. SPT blow-counts were correlated to unit weight as well as friction angle using guidance from Fang's Foundation Engineering Handbook [5]. Correlations were also based on the general material types encountered, using guidance from Reclamation's Design of Small Dams [6].

It is anticipated that excavation for new structures will extend two feet below the lowest points of the structures. This will allow for removal of soft or oversize particles immediately below the structure. Structural fill material will then be placed above the excavated surface and around the structures.

Material properties were provided for three representative materials: an in-situ foundation soil material, a structural fill material, and a bedrock material. A summary of material properties used in design is also provided in Table 8.

**Table 8. – Summary of Material Properties**

	Foundation Soil	Structural Fill	Bedrock
Dry Unit Weight (lb <sup>3</sup> /ft)	104	112	145
Moisture content (%)	6	12	5
Allowable bearing capacity (lb/ft <sup>2</sup> )	2,000	2,500	4,000
Modulus of Subgrade Reaction (ksf/ft)	150-300	150-300	1,000
Cohesion (psi)	0	0	0
Friction Angle (degrees)	33	33	35
OSHA Classification for Excavation Slopes	Type C (1.5H:1V, or flatter)	Type C (1.5H:1V, or flatter)	Type C (1.5H:1V, or flatter)

### 1. Foundation Material

The foundation material represents the alluvial material generally found to a depth of 5 to 10 feet. The alluvial material is composed primarily of sand and silt-sized particles, with clay-sized particles also encountered in some samples.

In-place density tests were performed on two samples, as discussed in section IV.A.2 above; however, both samples were classified as being a sandy, lean clay.

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Since less than 20 percent of laboratory tests on SPT samples classified the materials as lean clay (or sandy lean clay), the in-situ density tests may not represent the site very well.

**a. Unit Weight and Moisture Content**

Unit weight was determined using a correlation to SPT blow counts. Gunaratne's The Foundation Engineering Handbook [7] provides a correlation between SPT blow counts and moist unit weight; sands and clays with blow counts in the range of 10 to 30 correlate to a moist unit weight of 110 to 120 lb/ft<sup>3</sup>. SPT blow counts in the alluvial material ranged from about 14 to 35. For design, it was conservatively assumed that the alluvial material had a moist unit weight of 110 lb/ft<sup>3</sup>. SPT samples revealed an average moisture content of about 6 percent. For design, dry unit weight was therefore assumed to be 104 lb/ft<sup>3</sup>.

**b. Allowable Bearing Capacity**

Allowable bearing capacity was estimated based on correlations from "NAVFAC" Design Manual 7.01 [8]; for silty and clayey sands in a medium to compact condition, an allowable bearing capacity of 5 kips per square foot (ksf) was recommended for use. However, for design, it was considered appropriate to provide additional factor of safety and reduce the recommended bearing capacity to 2 ksf (2,000 lb/ft<sup>2</sup>).

**c. Modulus of Subgrade Reaction**

Modulus of subgrade reaction ( $k_s$ ) was estimated based on correlations from Bowles [9]. For a silty sand of medium density, guide values for  $k_s$  range from 150 to 300 ksf/ft.

**d. Cohesion and Friction Angle**

Shear strength parameters were estimated based on empirical data from Reclamation's Design of Small Dams [6]. Cohesion was assumed to be zero, assuming the finer materials consist primarily of silts. Friction angle ( $\Phi$ ) was estimated to be 33 degrees based on average tested values for compacted silty sand materials.

**e. OSHA Material Type for Excavation**

The foundation material is conservatively assumed to classify as a Type C soil per OSHA regulations, requiring excavation slopes of 1.5:1 (H:V) or flatter.

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Pumping Plant 7 – Geotechnical Design****2. Structural Fill**

After excavating to 2 feet below the bottom of each structure, structural fill will be placed up to the bottom of the surface, and then up to the final grade. The structural fill will likely be very similar to the foundation material. It is assumed to classify as a silty sand. Several material parameters are assumed to be the same as those estimated for the foundation material. However, since compaction and moisture properties will be controlled during placement, some material properties have been assumed to be different from those of the foundation material.

**a. Unit Weight and Moisture Content**

Unit weight was estimated by referencing empirical data from Reclamation's Design of Small Dams [6]; the average unit weight of a placed, silty sand material was found to be 112.0. This value compares well with the maximum dry density tested for the sample from TPPP7-16-6, although as previously mentioned this material was a sandy lean clay. Optimum moisture content is estimated to be 12 percent, which also compares well with the sample from TPPP7-16-6. Total unit weight was therefore provided for design as 125 lb/ft<sup>3</sup>.

**b. Allowable Bearing Capacity**

Bearing capacity was estimated based on correlations from "NAVFAC" Design Manual 7.01 [8], as was done for the foundation material above. However, the recommended allowable bearing capacity was increased slightly to 2.5 ksf (2,500 lb/ft<sup>2</sup>) to account for the increased compaction control.

**c. Modulus of Subgrade Reaction**

Modulus of subgrade reaction ( $k_s$ ) was assumed to be the same as the value presented above for the foundation material;  $k_s$  was assigned a range from 150 to 300 ksf/ft.

**d. Cohesion and Friction Angle**

Cohesion and friction angle strength parameters are assumed to be the same as those discussed above for the foundation material. Cohesion was assumed to be zero, and friction angle ( $\Phi$ ) was estimated to be 33 degrees.

**e. OSHA Material Type for Excavation**

The structural fill material is conservatively assumed to classify as a Type C soil per OSHA regulations, requiring excavation slopes of 1.5:1 (H:V) or flatter.

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Pumping Plant 7 – Geotechnical Design****3. Sandstone Bedrock****a. Unit Weight and Moisture Content**

Unit weights were not calculated from field samples for the sandstone bedrock. However, it is likely to be much denser than the overlying alluvial materials. It was assumed to have a dry unit weight of 145 lb/ft<sup>3</sup>. Field samples of the material did find a moisture content of around 5 percent. A total unit weight of 151 lb/ft<sup>3</sup> was therefore provided for use in design.

**b. Allowable Bearing Capacity**

Allowable bearing capacity was estimated based on guidance from “NAVFAC” Design Manual 7.01 [8]. An allowable bearing capacity of 4 ksf (4,000 lb/ft<sup>2</sup>) was provided for design.

**c. Modulus of Subgrade Reaction**

Modulus of subgrade reaction ( $k_s$ ) was estimated to be 1,000 ksf/ft based on correlations by Terzaghi [10] for a dense sand.

**d. Cohesion and Friction Angle**

Shear strength parameters were estimated based on guidance from Reclamation’s Design of Small Dams [6], and adjusted based on engineering judgment. Cohesion was assumed to be zero. Friction angle ( $\Phi$ ) was estimated to be 35 degrees.

**e. OSHA Material Type for Excavation**

Although the sandstone is more dense and structured than the alluvial materials, it is relatively soft at shallower depths. It is therefore assumed that it will break down into a sandy material during excavation, especially if subjected to precipitation. The sandstone is therefore conservatively assumed to classify as a Type C soil per OSHA regulations, requiring excavation slopes of 1.5:1 (H:V) or flatter.

**C. Liquefaction Potential**

Liquefaction is not considered to be a design concern. The water table was only encountered at depth, within sandstone and claystone materials that are very unlikely to be liquefiable. Liquefaction would therefore be unable to develop

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during seismic activity.

## **VII. Summary and Discussion**

Pumping Plant 7 and its appurtenant structures are to be constructed on alluvial materials overlying relatively shallow sandstone bedrock. Expansive bedrock was only encountered at depth or in small layers, but could be encountered in lenses that did not show up during exploratory borings. The alluvial materials, however, could exhibit some expansive behavior if areas with higher clay-content are widespread.

It is emphasized that there is risk involved in the construction of infrastructure in an area where expansive soils are present at a shallow depth. Furthermore, due to geologic variability and uncertainties, it is impossible to predict the actual magnitude of heave and when it may occur. *If expansive materials are encountered, the design team should be immediately contacted to allow for appropriate design adjustments.*

Alluvial soils will typically be removed down to bedrock during excavation for the structures. If potentially expansive materials are found to remain after excavating to grade, they should be removed down to sandstone. The area could then be built back up to grade using non-expansive materials. If non-expansive materials are unavailable from the site, the removed materials may be moisture conditioned to optimum moisture content (or slightly higher) to mitigate the potential for expansion.

A gravel drain system has been incorporated into the design to minimize the potential for damage to the water storage tanks due to soil expansion. The gravel drain system includes an HDPE geomembrane, allowing water leaking through the tanks to be collected and conveyed away from the foundation.

Additional measures are also included in the design to reduce the likelihood of damaging heave caused by expansive materials. The structures include gutters to collect precipitation and convey it away from the structures. Within ten feet of structures, the ground surface will be sloped at a minimum of 5 percent to reduce infiltration adjacent to the structures. The site will be graded to ensure drainage away from the structures and off-site. These measures are intended to minimize the amount of precipitation that finds its way into the foundation materials.

Lastly, it is advised that all concrete structures use Type V or Type HS (high sulfate) cement, due to the moderate chloride concentration observed in samples of the foundation materials.

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Pumping Plant 7 – Geotechnical Design****References**

- [1] "Geologic Design Data Report, San Juan Lateral, Pumping Plant 7," Navajo Gallup Water Supply Project, Bureau of Reclamation, Upper Colorado Region, Four Corners Construction Office, September 2016.
- [2] "Geologic Design Data Report, San Juan Lateral Block 9-11," Navajo Gallup Water Supply Project, U.S. Department of the Interior, Bureau of Reclamation, Four Corners Construction Office (Geology Group), Farmington, New Mexico, May 2016.
- [3] R. D. Holtz and W. D. Kovacs, *An Introduction to Geotechnical Engineering*, Englewood Cliffs: Prentice-Hall, 1981.
- [4] "Tohlakai Pumping Plant Foundation Recommendations," Technical Memorandum No. ZN-8312-3, Bureau of Reclamation, Technical Service Center, Denver, Colorado, September 2013.
- [5] H.-Y. Fang, *Foundation Engineering Handbook*, Springer US, 1991.
- [6] *Design of Small Dams*, U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, 2015.
- [7] M. Gunaratne, *Foundation Engineering Handbook*, 2nd ed., New York City: Cre, 2006.
- [8] "Soil Mechanics Design Manual 7.01", Naval Facilities Engineering Command, September 1986.
- [9] J. E. Bowles, *Foundation Design and Analysis*, 5th ed., New York: McGraw-Hill, 2001.
- [10] K. Terzaghi, "Evaluation of Coefficients of Subgrade Reaction," *Geotechnique*, vol. V, no. 4, pp. 41-50, 1955.
- [11] ""Geologic Design Data Report, San Juan Lateral, Pumping Plant 4," Navajo Gallup Water Supply Project, Bureau of Reclamation, Upper Colorado Region, Four Corners Construction Office, October 2016".
- [12] "Geologic Design Data Report, San Juan Lateral, Pumping Plant 4," Navajo Gallup Water Supply Project, Bureau of Reclamation, Upper Colorado Region, Four Corners Construction Office, October 2016.

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## **Figures**

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## **Appendix A - Recommendations**

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The recommendations in this appendix are based on the results of field explorations and laboratory testing. It is possible that subsurface conditions can vary between or beyond the points explored. If the subsurface conditions found during construction differ from those described in the geology section of this report, please notify Reclamation immediately so that we can review our report in light of those conditions in order to provide supplemental recommendations as necessary.

The report was prepared in substantial accordance with the generally accepted standards of practice for geotechnical engineering as exist in the project area at the time of this technical memorandum.

**1. Site Preparation and Grading****Subgrade**

After performing the required excavations and prior to the placement of fill, the excavated surface should be prepared. Any boulders along this surface should be removed and backfilled with compacted fill. If the excavated surface is not within pediment deposit, it should be scarified to a depth of at least 8 inches, and compacted to a minimum of 95-percent of maximum density, as determined using the modified proctor test.

**Excavation Slopes**

It is expected that both the pediment material and the weathered/decomposed claystone and bedrock materials will classify as Type C materials using OSHA criteria. OSHA requires that unsupported cuts up to 20-feet in height be laid back to ratios no steeper than 1.5H:1V (horizontal:vertical) for a Type C material. In general, these excavation slope ratios will be stable under temporary, unsaturated conditions. However, if runoff drains into the excavation, flatter slopes may be more appropriate. The actual determination of soil type and allowable sloping must be made in the field by an OSHA-qualified "competent person."

**Final Grading**

Positive drainage away from the structures is essential to the performance of foundations, floor slabs and flatwork, and should be provided during the life of the structures. Landscape areas should not be within 10 feet of the structures. Areas where pavements or slabs are constructed adjacent to the structures should slope away at a minimum grade of 5 percent within 10 feet of the structure. All downspouts from roof drains should cross all backfilled areas such that they discharge all water away from the backfill zone and the structure. Drainage should be created such that water is diverted off the site and away from adjacent buildings.

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All site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations, and other local, state or federal guidelines.

Site preparation should consist of clearing and grubbing topsoil, organic matter, and removal of deleterious material from areas to be filled and cut.

**2. *Structural Fill***

The structural fill is to be processed from the excavated materials. This will require screening it to remove particles larger than 3-inches in diameter. Excavated claystone materials are not to be used for structural fill, unless properly processed, mixed, and moisture conditioned. The structural fill should be low permeability and non-expansive, with a maximum swell potential of 1-percent or less under 1,000-pounds per square foot (psf) of surcharge when inundated with water. Additional moisture conditioning may be required during placement and compacting of structural fill.

The structural fill should be placed on a horizontal plane and placed in loose lifts not to exceed 6-inches in thickness. Structural fill is to be compacted to a minimum of 95-percent of maximum density, as determined using the modified proctor test. Moisture content is to be between optimum and 3-percent above optimum.

The structural fill should not contain particles exceeding 1 inch within 1 foot of the pipeline. Additionally, materials within 2 feet of a structure should have special compaction.

It is recommended that a low-permeability “cap” be placed within the top 3-feet of the ground surface around the structures; this will hinder infiltration of surface water below the structures, minimizing the potential for heave.

A Reclamation representative should be on-site during construction to observe preparation of the site, excavation for the buildings and storage tanks, and to test structural fill placement.

**3. *Construction in Wet or Cold Weather***

During construction, grade the site such that surface water can drain away from the construction areas free of obstructions. Promptly pump out or otherwise remove any water that may accumulate in excavations or on subgrade surfaces, and allow these areas to dry before resuming construction. Berms, ditches, and

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similar means may be used to prevent stormwater from entering the work area, and to convey water off site efficiently.

If earthwork is performed during the winter months when freezing is a factor, no non-structural grading fill, structural fill or other fill should be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to fill placement. A good practice is to cover the compacted fill with a “blanket” of loose fill to help prevent the newly placed structural fill from freezing.

If the building is erected during cold weather, foundations, concrete slab-on-grade floors, or other concrete elements should not be constructed on frozen soil. Frozen soil should be completely removed from beneath the concrete elements, or thawed, scarified, moisture-conditioned, and re-compacted. The amount of time passing between excavation or subgrade preparation and placing concrete should be minimized during freezing conditions to prevent the prepared soils from freezing. Blankets, soil cover or heating as required may be utilized to prevent the subgrade from freezing.

**4. Mitigation for Potential Heave if Expansive Materials are Encountered**

Recommendations for mitigation of expansive materials are provided in the main body of the report. Additional recommends are presented below.

For a shallow foundation system such as a reinforced mat foundation, a currently accepted mitigation technique for expansive soil sites is over-excavation of at least 10-feet below the bottom of the lowest foundation elements (i.e. the bottom of the pipe encasement for the pumping plant building). The over-excavation should also extend at least 10-feet laterally outward from the edge of the mat foundation; the 10-foot lateral extension of the foundation excavation should be measured at the bottom of the mat foundation excavation. The side slopes of the over-excavation should conform to OSHA requirements. The structural fill should be placed in the over-excavated area to support the mat foundation. The intent of constructing the mat foundation on at least 10-feet of structural fill is to reduce differential movements across the structure to about 1-inch. In order to achieve this result, careful construction and an adequate amount of testing during structural fill placement will be required. Testing should include moisture/density testing as well as swell testing of the structural fill.

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Pumping Plant 7 – Geotechnical Design****5. Reinforced Mat Foundation for Pumping Plant Building**

1. It is recommended that the multiple pipe joints system be designed to accommodate differential vertical movement of at least 1 inch.
2. In order to minimize differential settlements at the expansion joint location between building units, structural measures such as rebar dowels, etc. should be utilized at those locations.
3. Water pipes and other utility lines within the pumping plant building should be carefully leak tested after installation.
4. At the perimeter of the mat foundation, it is recommended to have at least 30 inches of soil cover above the bottom of the mat foundation for frost protection per local building department requirements.
5. The foundation subgrade and compacted structural fill should be protected from wetting and drying prior to, and after concrete placement. Foundation should be backfilled as soon as practical after concrete placement.
6. Landscaping that requires supplemental watering should not be established within 10 feet of the pumping plant building, slabs pavements, etc. Those areas may be covered with decorative gravel.

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## **Appendix B – Plan View With Borehole Locations**

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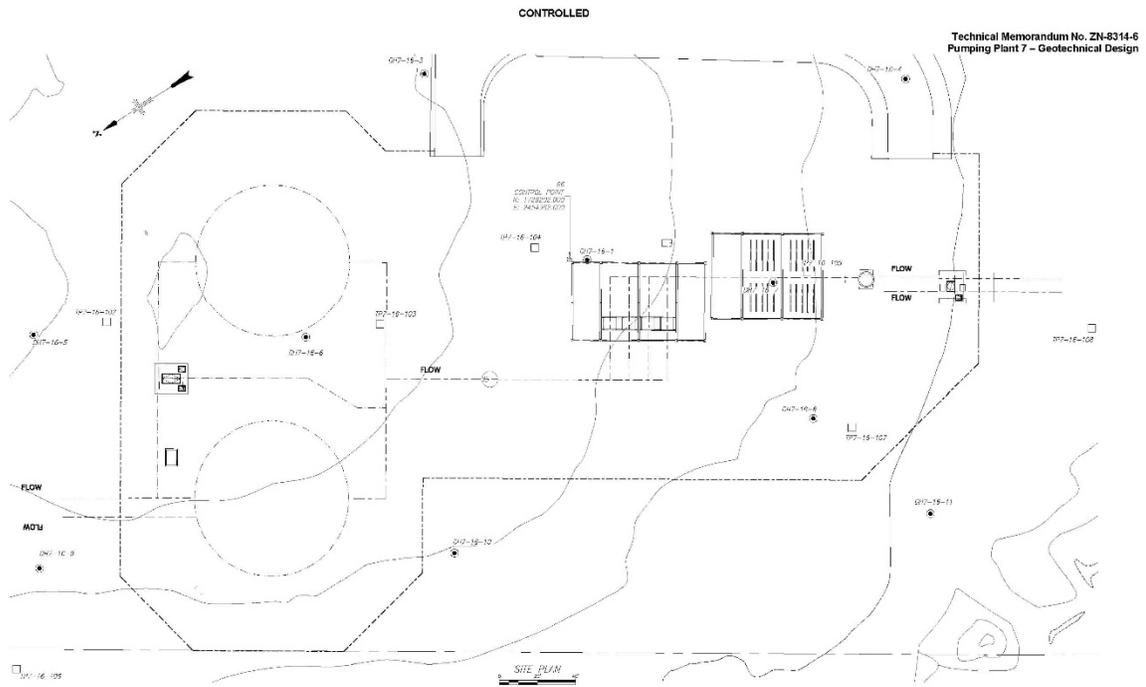


Figure 2. – Plan view showing drillhole and test pit locations (final surface shown)

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## **Appendix C – Typical Sections**

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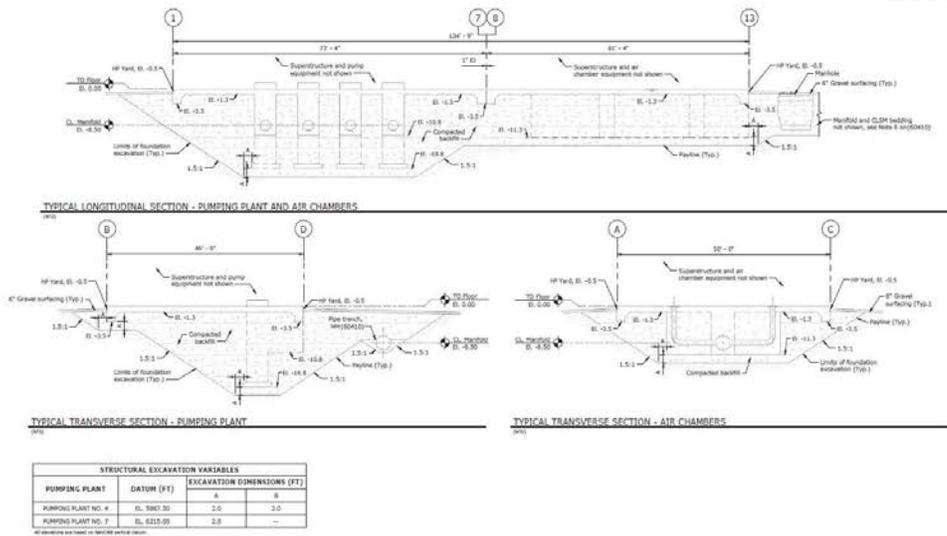


Figure 3. – Typical sections through structures at Pumping Plants 4 and 7, with relative elevation data (from draft version of drawing 1695-D-60409)

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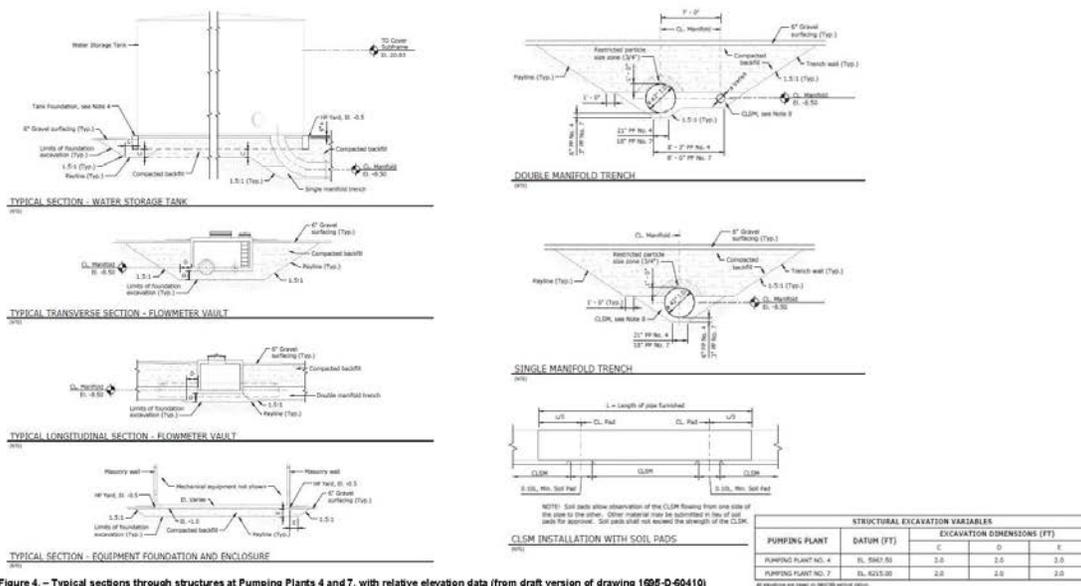


Figure 4. – Typical sections through structures at Pumping Plants 4 and 7, with relative elevation data (from draft version of drawing 1695-D-60410)

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## **Appendix D – Drill Hole Logs**

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GEOLOGIC LOG OF DRILL HOLE NO. DHPP7-16-1													SHEET 1 OF 1				
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project			STATE: New Mexico											
LOCATION: Pumping Plant			COORDINATES: N 1,729,194.4 E 2,454,357.6 53 State Plane			GROUND ELEVATION: 6212.4 ft. NAD-83											
BEGUN: 4/5/16 FINISHED: 4/7/16			TOTAL DEPTH: 39.5			ANGLE FROM HORIZONTAL: -99											
DEPTH AND ELEVATION OF WATER LEVEL: NE			DEPTH TO BEDROCK: 5.4			HOLE LOGGED BY: P. Garner											
DATE MEASURED: 4/7/2016						REVIEWED BY: J. Gilbert											
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RCD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killbrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: QME Model 95 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 8.5: 4.25 inch HSA and dry core system with SPT. 8.5 to 11.3: 4.25 inch HSA and dry core system with California Sampler. 11.3 to 39.5: HQ3 wireline coring system with 5 foot split tube sampler and carbide surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 11.3: None 11.3 to 39.5: Water</p> <p>DRILLING NOTES: 0.0 to 3.5: Pilot bit. 3.5 to 11.3: Dry core, easy auger to refusal. 11.3 to 24.5: HQ3 Easy drilling. 24.5 to 29.5: HQ3 No recovery, easy drilling. 29.5 to 34.5: HQ3 Easy drilling, difficult to recover core. 34.5 to 39.5: HQ3 Easy drilling, difficult to recover core because of washed sandstone. Lost bit in hole at 39.5. Abandoned hole.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following intervals for swell and laboratory testing. 3.5 to 5.0: SPT 8.5 to 9.5: California Sample</p>	0.0	Qal													SC	<p><b>0.0 to 5.4 ft QUATERNARY ALLUVIUM (Qal)</b> 0.0 to 5.4 ft CLAYEY SAND (SC): About 70% fine sand; about 30% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Brown and dry.</p>	
	5	84	NA				38.9	61.1	0.0	22.2	4.5	5.0	SC-SM	6/17/46		<p><b>5.4 to 39.5 ft CRETACEOUS MENEPEE FORMATION (Kmf)</b></p>	
	5.4																<p>5.4 to 11.3 ft SANDSTONE: Fine grained, tan to light brown and orange. Moderately soft (H5) and can be grooved with knife. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes and FeOx and CaCO<sub>3</sub> in joints. No to weak reaction with HCl. Laminated to thin bedding. Bedding planes near horizontal.</p>
	10	97				5	7										<p>11.3 to 13.8 ft SANDSTONE: Fine grained, light to dark gray in color. Hard (H5) and difficult to scratch with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Strong reaction with HCl. Laminated to thin bedding. Bedding planes near horizontal. Highly fractured zone between 13.3 and 13.5 ft.</p>
	15	66	44		3												<p><b>JOINT MEASUREMENTS:</b> DEPTH INCL R O T HL INFILLING 12.5 10° 5 0 0 1 FeOx</p>
	20	100	70														<p>13.8 to 34.5 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be grooved with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes vary from 10° to near horizontal. No recovery between 24.5 and 29.5 ft</p>
	25	42	0				4										<p>34.5 to 39.5 ft SANDSTONE: No recovery. Core washed away with cuttings.</p>
	30	NR	0			5											<p><b>STRATIGRAPHY:</b> <b>0.0 to 5.4 ft: QUATERNARY ALLUVIUM (Qal)</b> <b>5.4 to 39.5 ft: CRETACEOUS MENEPEE FORMATION (Kmf)</b></p>
	35	94	0														
			NR	0													<p>6172.9</p> <p>BOTTOM OF HOLE</p>

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO<sub>3</sub>= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTONE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for design and specification as follows "Drawing No. 40-D-6483 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.

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GEOLOGIC LOG OF DRILL HOLE NO. DHPP7-16-2														SHEET 1 OF 1				
FEATURE: Pumping Plant 7			PROJECT: Navajo Callup Water Supply Project			STATE: New Mexico												
LOCATION: Foundation Investigation			COORDINATES: N 1,729,464.4 E 2,454,630.5 83 State Plane			GROUND ELEVATION: 6210.5 ft. NAD-83												
BEGIN: 7/19/16 FINISHED: 7/19/16			TOTAL DEPTH: 30.0			ANGLE FROM HORIZONTAL: -90												
DEPTH AND ELEVATION OF WATER LEVEL: 29.5 ft. (6180.7)			DEPTH TO BEDROCK: 8.8			HOLE LOGGED BY: C. Dayer												
DATE MEASURED: 7/19/2016						REVIEWED BY: J. Gilbert												
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RDP	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION		
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION					
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Ruben Perez HELPER: Bob Simmons</p> <p>PURPOSE: Precastrection soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 30.0. 4.25 inch HSA and dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 30.0. None</p> <p>DRILLING NOTES: Core chewed up by auger, recovered as thin vesicles.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLES: Sampled following interval for laboratory testing. 4.0 to 5.5 SPT</p>																0.0 to 8.8 ft. QUATERNARY ALLUVIUM (Qal)		
		42															0.0 to 6.8 ft. CLAYEY SAND (SC): About 75% fine sand; about 25% fines with medium plasticity, medium toughness, medium dry strength and slow dilatancy; maximum size, fine sand; strong reaction with HCl.	
		5	Qal					28.8	71.2	0.0	24.0	6.2	5.1	SC-SM	19/13/12		8.8 to 30.0 ft. CRETACEOUS MENEFEE FORMATION (Kmf)	
		26															8.8 to 30.0 ft. SANDSTONE: Fine grained, light to dark brown and orange, very soft (H7) to soft (H6), moderately to intensely weathered (W5), thin to moderately bedded, bedding planes near horizontal. Core separates along bedding planes, FeOx staining, weak reaction with HCl. Core becomes moist below 15.0 ft. and wet from 29.5 to 30.0 ft. Groundwater measured at 29.5 ft before backfilling hole.	
		10				7	8									620.7	STRATIGRAPHY:	
		100																0.0 to 8.8 ft. QUATERNARY ALLUVIUM (Qal)
		15			NA													8.8 to 30.0 ft. CRETACEOUS MENEFEE FORMATION (Kmf)
		100																
		20	Kmf			6	6											SS
		100																
	25																	
	100																	
	30																6180.5	
BOTTOM OF HOLE																		
<p>COMMENTS:</p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>																		

SHEET 1 OF 1 | DRILL HOLE DHPP7-16-2

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHPP7-16-3

SHEET 1 OF 1

FEATURE: Pumping Plant 7 PROJECT: Navajo Gallup Water Supply Project STATE: New Mexico  
 LOCATION: Foundation Investigation COORDINATES: N 1,729,213.0 E 2,454,486.3 83 State Plane GROUND ELEVATION: 6212.1 ft. NAD-83  
 BEGUN: 7/15/16 FINISHED: 7/17/16 TOTAL DEPTH: 35.8 ANGLE FROM HORIZONTAL: -90  
 DEPTH AND ELEVATION OF WATER LEVEL: 30.7 ft. (6181.4) DEPTH TO BEDROCK: 4.5 HOLE LOGGED BY: P. Gardner C. Bayer  
 DATE MEASURED: 7/16/2016 REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew                      DRILLER: Sean Rafferty                      HELPER: Ruben Perez                      HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 95 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 18.0: 4.25 inch HSA and dry core system with SPT.                      18.0 to 19.0: 4.25 inch HSA with Pilot Bit.                      19.0 to 35.8: HQ3 wireline coring system with 5 foot split tube sampler and diamond surface set bit.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 19.0: None                      19.0 to 35.8: Water</p> <p>DRILLING NOTES: Reached Auger refusal at 18.0 ft. and drilled to 19.0 ft. with pilot bit. Switched to core setup at 19.0 ft.</p> <p>HOLE COMPLETION: Ground water monitoring well installed with standpipe.                      3.0 to 25.4: Solid 2 inch PVC                      25.4 to 35.4: 0.020" Slotted screen                      Backfilled hole to surface as shown on diagram.                      0.0 to 1.0: Concrete                      1.0 to 24.0: Bentonite                      24.0 to 35.8: #10-20 Sand.</p> <p>SAMPLES: Sampled following intervals for laboratory testing:                      3.5 to 5.0: SPT                      8.5 to 10.0: SPT</p>	0.0		100												SM	0.0 to 2.8 ft. SLTY SAND (SM): About 70% fine sand; about 30% nonplastic fines with rapid dilatancy and low dry strength; maximum size, fine sand; no reaction with HCl.	
	2.8														s(CL)	2.8 to 4.5 ft. SANDY LEAN CLAY s(CL): About 60% fines with medium plasticity, high dry strength and medium toughness; about 40% fine sand; maximum size, fine sand; strong reaction with HCl; calcite stringers, dark brown in color.	
	4.5		64														4.5 to 35.8 ft. CRETACEOUS MENEFFEE FORMATION (Kmf)
	4.5																4.5 to 11.3 ft. SANDSTONE: Light brown in color. Very soft (H7), decomposed (W9) to very intensely weathered (W8) and can be classified as "POORLY GRADED SAND WITH SILT" with about 90% fine sand; about 10% nonplastic fines with rapid dilatancy and low dry strength; maximum size, fine sand; no reaction with HCl.
	11.3																11.3 to 17.5 ft. SANDSTONE: Fine grained, light to dark brown and orange. Very soft (H7) to Soft (H6), moderately to intensely weathered (W6), thin to moderately bedded, bedding planes near horizontal. Core separates along bedding planes, FeOx staining, weak reaction with HCl.
	17.5			NA		7	7										17.5 to 21.0 ft. SANDSTONE: Fine grained, gray in color and calcareous. Hard (H5), slightly weathered to fresh (W3), thin to moderately bedded. Strong reaction with HCl.
	21.0																21.0 to 34.7 ft. POOR RECOVERY: Recovered material is fine grained, light to dark brown and orange. Very soft (H7) to Soft (H6), moderately weathered (W5), thin to moderately bedded, bedding planes near horizontal. Core separates along bedding planes, FeOx staining, weak reaction with HCl.
	34.7																34.7 to 35.8 ft. CLAYSTONE: Gray in color, soft (H6), moderately weathered (W5), sandy and thin to moderately bedded. Slakes rapidly, no reaction with HCl.
																	STRATIGRAPHY: 0.0 to 4.5 ft.: QUATERNARY ALLUVIUM (Cal) 4.5 to 35.8 ft.: CRETACEOUS MENEFFEE FORMATION (Kmf)
																	6177.4 CLSTNE 6178.3
																4.5	

COMMENTS:  
 HSA=hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.

Observation well installed

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**Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design**

**GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-4**

SHEET 1 OF 1

FEATURE: Pumping Plant 7	PROJECT: Navajo Gallup Water Supply Project	STATE: New Mexico
LOCATION: Foundation Investigation	COORDINATES: N 1,729,002.1 E 2,454,346.7 83 State Plane	GROUND ELEVATION: 6214.3 ft. NAD-83
BEGIN: 7/18/16 FINISHED: 7/18/16	TOTAL DEPTH: 34.0	ANGLE FROM HORIZONTAL: -90
DEPTH AND ELEVATION OF WATER LEVEL: NE	DEPTH TO BEDROCK: 7.3	HOLE LOGGED BY: C. Boyer
DATE MEASURED: 7/18/2016		REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION			
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Great Plains Drill Crew DRILLER: Sean Rafferty HELPER: Ruben Perez HELPER: Bob Sammons</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: ONE Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 19.0: 4.25 inch HSA and dry core system. 19.0 to 21.5: 4.25 inch HSA with pilot bit. 21.5 to 34.0: 4.25 inch HSA and dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 34.0: None</p> <p>DRILLING NOTES: Reached hard sandstone at 17.0. Augering was very slow and difficult for about 40 minutes. Crew switched to pilot bit to penetrate hard sandstone bed without sampling from 19.0 to 21.5.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLES: Sampled following interval for laboratory testing: 4.0 to 5.5: SPT</p>	0.0	Qal													0.0 to 7.3 ft QUATERNARY ALLUVIUM (Qal)	
	5.0															0.0 to 7.3 ft CLAYEY SAND (SC): About 75% fine sand; about 25% fines with medium plasticity, medium toughness, medium dry strength and slow dilatancy; maximum size, fine sand; strong reaction with HCl.
	7.3															7.3 to 34.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
	7.3															7.3 to 17.0 ft SANDSTONE: Fine grained, light to dark brown and orange. Very soft (H7) to soft (H8), moderately to intensely weathered (W6), thinly to moderately bedded, bedding planes near horizontal. Core separates along bedding planes. FeOx staining, weak reaction with HCl.
	17.0				7	7										17.0 to 21.5 ft SANDSTONE: Fine grained, gray in color and calcareous. Hard (H5), slightly weathered to fresh (W3), thinly to moderately bedded. Strong reaction with HCl.
	21.5															21.5 to 34.0 ft SANDSTONE: Fine grained, light to dark brown and orange. Soft (H6), moderately weathered (W5), thinly to moderately bedded, bedding planes near horizontal. Core separates along bedding planes. FeOx staining and weak reaction with HCl. Core recovered in thin waters.
	19.0															STRATIGRAPHY: 0.0 to 7.3 ft: QUATERNARY ALLUVIUM (Qal) 7.3 to 34.0 ft: CRETACEOUS MENEFEE FORMATION (Kmf)
	19.0															
	21.5															
	21.5															

**COMMENTS:**

HSA=hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities.

SHEET 1 OF 1 | DRILL HOLE DHP7-16-4

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**Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design**

**GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-6**

SHEET 1 OF 1

FEATURE: Pumping Plant 7	PROJECT: Navajo Callup Water Supply Project	STATE: New Mexico
LOCATION: Tank	COORDINATES: N 1,729,341.5 E 2,454,402.4 83 State Plane	GROUND ELEVATION: 6211.0 ft. NAD-83
BEGIN: 4/9/16 FINISHED: 4/9/16	TOTAL DEPTH: 49.5	ANGLE FROM HORIZONTAL: -90
DEPTH AND ELEVATION OF WATER LEVEL: NE	DEPTH TO BEDROCK: 3.4	HOLE LOGGED BY: P. Carstner
DATE MEASURED: 4/9/2016		REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Gilbreth HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 21.5: 4.25 inch HSA and dry core system with SPT. 21.5 to 23.0: 4.25 inch HSA and dry core system with Pilot Bit. 23.0 to 49.5: HQ3 wireline coring system with 5 foot split tube sampler and caside surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 23.0: None 23.0 to 49.5: Water</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit. 3.0 to 21.5: Dry core, easy auger to refusal. 21.5 to 23.0: HSA with pilot bit. No recovery. 23.0 to 29.5: HQ3 Typical drilling 29.5 to 34.5: HQ3 Poor recovery, washed by drill. 34.5 to 48.5: HQ3 Easy drilling.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following intervals for laboratory testing: 3.0 to 4.5: SPT 5.5 to 7.0: SPT 10.5 to 12.0: SPT 13.0 to 14.5: SPT 18.0 to 19.5: SPT</p>	0	Qal													0.0 to 3.4 ft QUATERNARY ALLUVIUM (Qal)		
		5		100				28.8	71.2	0.0	NA	NP	4.6	SM	10/15/19	SC	0.0 to 3.4 ft CLAYEY SAND (SC): About 80% fine sand; about 20% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Light brown and moist.
		10		94		7		22.9	77.1	0.0	NA	NP	4.1	SM	13/34/50	3.4 to 43.5 ft CRETACEOUS MENEFEE FORMATION (Kmf)	
		15		100		7		25.5	74.5	0.0	NA	NP	5.3	SM	33/50/NA	3.4 to 7.7 ft SANDSTONE: Fine grained, tan to light brown. Decomposed (W9) and scatter than (H7) and can be classified as "SILTY SAND" with about 55% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; no to weak reaction with HCl. Light brown and moist. Clayclasts found between 7.0 and 7.7 ft.	
		20		100		5		28.5	71.5	0.0	NA	NP	6.4	SM	37/50/NA	7.7 to 15.0 ft SANDSTONE: Fine grained, tan to light brown and orange. Moderately soft (H5) and can be easily grooved with knife. Intensely weathered (W7) discolored and oxidation throughout. Easily broken on bedding planes and FeOx and CaCOx in joints. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. Carbonaceous blebs and lamination present.	
		25		100		3		26.8	73.2	0.0	NA	NP	8.6	SM	34/50/NA	15.0 to 15.6 ft SANDSTONE: Fine grained, light gray in color. Hard (H3) and difficult to scratch with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Strong reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. Highly fractured.	
		30		NR	0											15.6 to 35.1 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be easily grooved with knife. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal. No recovery between 21.5 and 23.0 ft. Claystone interval between 29.5 and 29.0 ft and between 34.4 and 34.5 ft.	
		35		100	0	5										35.1 to 49.5 ft CLAYSTONE: Light to dark gray and mottled with black and red. Soft (H6) and can be scratched with thumbnail. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. No reaction with HCl. FeOx staining present. Laminated to thinly bedded. Bedding planes vary from 10" to near horizontal.	
		40		100	94											STRATIGRAPHY: 0.0 to 3.4 ft: QUATERNARY ALLUVIUM (Qal) 3.4 to 43.5 ft: CRETACEOUS MENEFEE FORMATION (Kmf)	
		45		100	92		6									CLSTNE	
		49.5		100	92											CLSTNE	
																610.5	BOTTOM OF HOLE

**COMMENTS:**

HSA=hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHPP7-16-7

SHEET 1 OF 1

FEATURE: Pumping Plant 7  
LOCATION: Surge Tank  
BEGIN: 4/12/16 FINISHED: 4/12/16  
DEPTH AND ELEVATION OF WATER LEVEL: NE  
DATE MEASURED: 4/12/2016

PROJECT: Navajo Callup Water Supply Project  
COORDINATES: N 1,729,119.0 E 2,454,294.3 83 State Plane  
TOTAL DEPTH: 39.7  
DEPTH TO BEDROCK: 4.9

STATE: New Mexico  
GROUND ELEVATION: 6213.7 ft. MAD-83  
ANGLE FROM HORIZONTAL: -90  
HOLE LOGGED BY: P. Gardner  
REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RDP	HARDNESS	WEATHERING	LABORATORY DATA							BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Kilbreth HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 4.5: 4.25 inch HSA and dry core system with SPT. 4.5 to 17.0: 4.25 inch HSA and dry core system. 17.0 to 18.0: 4.25 inch HSA and dry core system with Pilot Bit. 18.0 to 38.7: HQ3 wireline coring system with 5 foot split tube sampler and carbide surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 18.0: None 18.0 to 38.7: Water</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit. 3.0 to 17.0: Dry core, easy auger to refusal. 17.0 to 18.0: HSA with pilot bit. No recovery. 18.0 to 19.7: HQ3 Easy drilling. 19.7 to 24.7: HQ3 Poor recovery, washed by drill. 24.7 to 29.7: HQ3 Easy drilling. 29.7 to 34.7: HQ3 Poor recovery, washed by drill. 34.7 to 38.7: HQ3 Easy drilling.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following interval for laboratory testing. 3.0 to 4.5: SPT</p>																0.0 to 4.9 ft. QUATERNARY ALLUVIUM (Qal)	
		Qal															0.0 to 4.9 ft. CLAYEY SAND (SC). About 70% fine sand; about 30% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Brown and dry.
		5	80			7		55.8	44.2	0.0	30	15.5	7.9	n(CL)	6/8/14		4.9 to 33.7 ft. CRETACEOUS MENEPEE FORMATION (Kmf)
		10	100			7											4.9 to 10.3 ft. SANDSTONE: Fine grained, tan to light brown. Very soft (H7) and can be gouged with fingernail. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes and FeOx and CaCO3 in joints. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.
		15	98			5											10.3 to 17.0 ft. SANDSTONE: Fine grained, tan to light brown. Moderately soft (H5), can be scratched with moderate pressure of a knife. Intensely weathered (W7), discolored and oxidation throughout. Friable and FeOx staining. Thinly to moderately bedded near horizontal. Separates on bedding planes. No reaction with HCl.
		20	NR			3	4										17.0 to 18.8 ft. SANDSTONE: Fine grained and gray. Hard (H3) and moderately to slightly weathered (W4). Strong reaction with HCl. HSA with pilot bit and no recovery between 17.0 and 18.0 ft.
		25	100	0		5	7										18.8 to 38.1 ft. SANDSTONE: Fine grained, tan and light to dark brown. Moderately soft (H5) to soft (H6) and can be easily gouged with knife. Intensely weathered (W7) becoming intensely to moderately weathered (W6) below 19.4 ft. Friable, easily broken on bedding planes, FeOx and MnOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes from 10° to horizontal. Clay rip up clasts from 28.5 to 34.2 ft.
		30	20	0													38.1 to 39.7 ft. CLAYSTONE: Light to dark gray, soft (H8) and can be scratched with thumbnail. Moderately weathered (W5) with discoloration and oxidation. Laminated to moderately bedded. No reaction with HCl.
		35	100	66		6											STRATIGRAPHY: 0.0 to 4.9 ft. QUATERNARY ALLUVIUM (Qal) 4.9 to 38.7 ft. CRETACEOUS MENEPEE FORMATION (Kmf)
			40	14			6										CLSTNE 6174.0
			100	36		5	5										6175.6
						6	5										6174.0
																BOTTOM OF HOLE	

COMMENTS:

HSA=hollow stem auger NA=not available ft=feet NE=not encountered NP=non plastic NR=no recovery HCl=hydrochloric acid FeOx=iron oxide CaCO3=calcium carbonate MnOx=manganese oxide SPT=standard penetration test HQ3=coring system SS=sandstone CLSTNE=claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.

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**Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design**

GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-10												SHEET 1 OF 1			
FEATURE: Pumping Plant 7			PROJECT: Navajo Gallup Water Supply Project			STATE: New Mexico			GROUND ELEVATION: 6212.8 ft. NAD-83						
LOCATION: Foundation Investigation			COORDINATES: N 1,729,336.9 E 2,454,265.7 83 State Plane			TOTAL DEPTH: 40.0			ANGLE FROM HORIZONTAL: -90						
BEGIN: 4/11/16 FINISHED: 4/11/16			DEPTH TO BEDROCK: 6.0			HOLE LOGGED BY: P. Garner			REVIEWED BY: J. Gilbert						
DATE MEASURED: 4/11/2016															
NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION		
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: Kyle Killbrew HELPER: Joe Proctor HELPER: Renato Matheson</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD: 0.0 to 4.5: 4.25 inch HSA and dry core system with SPT. 4.5 to 14.0: 4.25 inch HSA and dry core system. 14.0 to 15.5: 4.25 inch HSA and dry core system with Pilot Bit. 15.5 to 26.5: 4.25 inch HSA and dry core system. 26.5 to 28.5: 4.25 inch HSA and dry core system with Pilot Bit. 28.5 to 40.0: HQ3 wireline coring system with 5 foot split tube sampler and carbide surface set bit.</p> <p>CASING RECORD: None used</p> <p>DRILLING MEDIUM: 0.0 to 26.5: None 26.5 to 40.0: Water</p> <p>DRILLING NOTES: 0.0 to 3.0: Pilot bit. 3.0 to 14.0: Dry core, easy auger to refusal. 14.0 to 15.5: HSA with pilot bit. 15.5 to 26.5: Dry core to refusal. 26.5 to 28.5: HSA with pilot bit with no advancement. 28.5 to 40.0: HQ3 typical drilling. Water loss at 28.0. Water returned at 36.0.</p> <p>HOLE COMPLETION: Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES: Sampled following interval for laboratory testing 3.0 to 4.5: SPT</p>	0.0	Qal												0.0 to 6.0 ft QUATERNARY ALLUVIUM (Qal)	
	5		80				36.3	63.7	0.0	24.4	5.6	4.7	SC-SM	3/10/9	0.0 to 3.4 ft CLAYEY SAND (SC): About 70% fine sand; about 30% fines with low plasticity; low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Brown and dry.
															3.4 to 6.0 ft SILTY SAND (SM): About 85% fine sand; about 15% non-plastic fines with no dry strength and negligible dilatancy; maximum size, fine sand; strong reaction with HCl. Light brown and dry.
						6									6.0 to 40.0 ft CRETACEOUS MENEFEE FORMATION (Kmf)
							7								6.0 to 11.2 ft SANDSTONE: Fine grained, tan to light brown and orange. Soft (H6) and intensely weathered (W7). Friable, easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal.
							7								11.2 to 16.8 ft SANDSTONE: Fine grained, tan to light brown and orange. Very soft (H7) and can be easily scratched with thumbnail. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes and FeOx staining. No to weak reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. No recovery and very difficult to auger with pilot bit from 14.0 to 15.5 ft.
						NA	NA								16.8 to 26.5 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be probed with a knife with moderate pressure. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal.
						7	7								26.5 to 32.7 ft SANDSTONE: Fine grained, light to dark gray in color. Hard (H3) and moderately to slightly weathered (W4). Strong reaction with HCl. Laminated to thinly bedded. Bedding planes near horizontal. Highly fractured between 29.4 to 30.7 ft.
															JOINT MEASUREMENTS: DEPTH INCL R O T HIL INFILLING 27.7 50° 5 1 1 3 FeOx
															32.7 to 33.1 ft CLAYSTONE: Dark brown. Soft (H6) and can be scratched with thumbnail. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. No reaction with HCl. FeOx staining present. Laminated to thinly bedded.
														33.1 to 35.4 ft SANDSTONE: Fine grained, light to dark brown. Soft (H6) and can be scratched with thumbnail. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. Easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes from 10° to horizontal.	
														35.4 to 40.0 ft SANDSTONE: Fine grained, light to dark gray and argillaceous. Moderately soft (H5) and can be probed with a knife with moderate pressure. Moderately to slightly weathered (W4) with limited discoloration and preserved texture. FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes from 10° to horizontal.	
														STRATIGRAPHY: 0.0 to 6.0 ft: QUATERNARY ALLUVIUM (Qal) 6.0 to 40.0 ft: CRETACEOUS MENEFEE FORMATION (Kmf)	
<p>COMMENTS:</p> <p>HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone</p> <p>The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for designs and specification as follows "Drawing No. 40-D-6483 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.</p>												SHEET 1 OF 1			

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

GEOLOGIC LOG OF DRILL HOLE NO. DHP7-16-11

SHEET 1 OF 1

FEATURE: Pumping Plant 7 PROJECT: Navajo Gallup Water Supply Project STATE: New Mexico  
 LOCATION: Foundation Investigation COORDINATES: N 1,729,115.7 E 2,454,147.0 83 State Plane GROUND ELEVATION: 6215.1 ft NAD-83  
 BEGUN: 4/11/16 FINISHED: 4/11/16 TOTAL DEPTH: 41.0 ANGLE FROM HORIZONTAL: -90  
 DEPTH AND ELEVATION OF WATER LEVEL: 39.0 ft (6178.1) DEPTH TO BEDROCK: 7.3 HOLE LOGGED BY: P. Garner  
 DATE MEASURED: 4/11/2016 REVIEWED BY: J. Gilbert

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% ROD	HARDNESS	WEATHERING	LABORATORY DATA							LABORATORY CLASSIFICATION	BLOWES 10.5 FT	USUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>All measurements are reported in feet except where noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew                      DRILLER: Kyle Gilbert                      HELPER: Joe Proctor                      HELPER: Renato Matheson</p> <p>PURPOSE:                      Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT:                      ONE Model 85 truck mounted rotary drill rig</p> <p>DRILL METHOD:                      0.0 to 9.5: 4.25 inch HSA and dry core system with SPT.                      9.5 to 40.0: 4.25 inch HSA and dry core system.                      40.0 to 41.0: 4.25 inch HSA and dry core system with California Sampler.</p> <p>CASING RECORD:                      None used</p> <p>DRILLING MEDIUM:                      0.0 to 41.0: None</p> <p>DRILLING NOTES:                      0.0 to 3.0: Pilot bit.                      3.0 to 41.0: Dry core, easy auger. Water level measured at 39.0.</p> <p>HOLE COMPLETION:                      Backfilled with bentonite and auger cuttings.</p> <p>SAMPLES:                      Sampled following intervals for swell and laboratory testing.                      3.0 to 4.5: SPT                      8.0 to 9.5: SPT                      15.5 to 17.4: Bag sample                      40.0 to 41.0: California Sample</p>	0.0 to 7.3 ft	Qal														0.0 to 7.3 ft QUATERNARY ALLUVIUM (Qal)	
	7.3 to 10.5 ft																7.3 to 10.5 ft CLAYEY SAND (SC): About 70% fine sand; about 30% fines with low plasticity, low dry strength, low toughness and no dilatancy; maximum size, fine sand; strong reaction with HCl. Brown and dry.
	10.5 to 15.5 ft	64															7.3 to 41.0 ft CRETACEOUS MENEPEE FORMATION (Kmf)
	15.5 to 17.4 ft																7.3 to 10.5 ft SANDSTONE: Fine grained, tan to light brown. Very soft (H7), decomposed (W9) and can be described as "SILT SAND" with about 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl.
	17.4 to 23.8 ft	84															10.5 to 15.5 ft SANDSTONE: Fine grained, tan to light brown and orange. Soft (H6) and can be scratched with thumbnail. Intensely weathered (W7) discolored and oxidation throughout. Friable and FeOx staining present. No to weak reaction with HCl.
	23.8 to 28.0 ft																15.5 to 17.4 ft CLAYSTONE: Dark brown. Soft (H5) and can be scratched with thumbnail. Moderately weathered (W5) with discoloration and oxidation. No reaction with HCl. FeOx staining present.
	28.0 to 39.0 ft	96															17.4 to 23.8 ft SANDSTONE: Fine grained, tan to light brown. Very soft (H7) and can be easily scratched with thumbnail. Intensely weathered (W7) discolored and oxidation throughout. Friable and FeOx staining present. No to weak reaction with HCl.
	39.0 to 41.0 ft																23.8 to 28.0 ft SANDSTONE: Fine grained and brownish yellow. Moderately soft (H5) and can be grooved with a knife with moderate pressure. Intensely weathered (W7) discolored and oxidation throughout. FeOx staining present. No to weak reaction with HCl.
	41.0 to 41.0 ft	100															28.0 to 39.0 ft SANDSTONE: Fine grained, light to dark brown. Moderately soft (H5) and can be grooved with a knife with moderate pressure. Intensely weathered (W7) discolored and oxidation throughout. Friable, easily broken on bedding planes and FeOx staining present. No to weak reaction with HCl. Laminated to moderately bedded. Bedding planes near horizontal. Clay rip-up clasts found from 33.2 to 33.7 ft.
	41.0 to 41.0 ft	98															39.0 to 41.0 ft CLAYSTONE: Dark gray. Soft (H6) and can be scratched with thumbnail. Moderately weathered (W5) with discoloration and oxidation. No reaction with HCl.
	41.0 to 41.0 ft	100															STRATIGRAPHY: 0.0 to 7.3 ft: QUATERNARY ALLUVIUM (Qal) 7.3 to 41.0 ft: CRETACEOUS MENEPEE FORMATION (Kmf)
	41.0 to 41.0 ft	NA															6178.1 6174.1

COMMENTS:  
 HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCO3= calcium carbonate  
 MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTNE= claystone

The data for the center column and "classification and physical conditions" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled for design and specification as follows "Drawing No. 40-D-6483 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6489 Standard Descriptors and Descriptive Criteria for Discontinuities.

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Pumping Plant 7 – Geotechnical Design**

## **Appendix E – Test Pit Logs**

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPPP7-16-1</b>		SHEET 1 OF 1	
FEATURE: Pumping Plant 7		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Tank Site		GROUND ELEVATION: 6210.6			
COORDINATES: N 1,729,491 E 2,454,517		METHOD OF EXPLORATION: Deere 310k Backhoe			
APPROXIMATE DIMENSIONS: 8x16x12.0		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 6/6/2016		DATE EXCAVATED: 6/6/2016			
DEPTH ft	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL  (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1 2 3 3.7 ft (6206.9)	SC	0.0 to 3.7 ft CLAYEY SAND: About 65% fine sand; about 35% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; maximum size, fine sand; strong reaction with HCl.  IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous. Calcium carbonate stringers present.  GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
4 5 6 7 8 9 10 11 12.0 ft (6198.6)	SANDSTONE	3.7 to 12.0 ft SANDSTONE: Fine grained. Tan and light brown in color. Very soft (H7) easily scratched with thumbnail. Very intensely weathered (W8) to intensely weathered (W7) below 6.0 ft. FeOx and MnOx staining present. Laminated to thinly bedded. No reaction with HCl. Excavated in flat, gravel to cobble size chunks. Calcium carbonate intervals at 4.3, 4.8, 5.5 and 6.8 ft about 1 inch in thickness.  GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf)			
COMMENTS: Surface vegetation consists of grasses and sage brush. Discontinued hole due to refusal on bedrock.					

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**Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design**

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPPP7-16-2</b>		SHEET 1 OF 1	
FEATURE: Pumping Plant 7		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Tank Site		GROUND ELEVATION: 6211.1			
COORDINATES: N 1,729,425 E 2,454,466		METHOD OF EXPLORATION: Deere 310k Backhoe			
APPROXIMATE DIMENSIONS: 8x16x9.9		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 6/6/2016		DATE EXCAVATED: 6/6/2016			
DEPTH ft	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL  (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1 2 3 3.8 ft (6207.3)	SC	0.0 to 3.8 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; maximum size, fine sand; strong reaction with HCl.  IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous. Roots present.  GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
4 5 6 7 8 9 9.9 ft (6201.2)	SANDSTONE	3.8 to 9.9 ft SANDSTONE: Fine grained. Tan and light brown in color. Very soft (H7) easily scratched with thumbnail and intensely weathered (W7). FeOx and MnOx staining present. Laminated to thinly bedded. No reaction with HCl. Excavated in flat, gravel to cobble size chunks. Calcium carbonate intervals at 6.0, 6.5, 7.0 and 7.8 ft about 1 inch in thickness.  GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf)			
COMMENTS: Surface vegetation consists of grasses and sage brush. Discontinued hole due to refusal on bedrock.					

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPPP7-16-3		SHEET 1 OF 1	
FEATURE: Pumping Plant 7		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Tank Site		GROUND ELEVATION: 6211.6			
COORDINATES: N 1,729,305 E 2,454,387		METHOD OF EXPLORATION: Deere 310k Backhoe			
APPROXIMATE DIMENSIONS: 8x16x9.4		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 6/6/2016		DATE EXCAVATED: 6/6/2016			
H. DEPT.	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1 2 3 3.4 ft (6208.2)	SC	0.0 to 3.4 ft CLAYEY SAND: About 60% fine sand; about 40% fines with low plasticity, low toughness, low dry strength and no dilatancy; maximum size, fine sand; weak reaction with HCl.  IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous. Roots present.  GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
4 5 6 7 8 9 9.4 ft (6202.2)	SANDSTONE	3.4 to 9.4 ft SANDSTONE: Fine grained. Tan and light brown in color. Soft (H6), can be scratched with thumbnail and intensely weathered (W7). FeOx and MnOx staining present. Laminated to thinly bedded. No reaction with HCl. Excavated in flat, gravel to cobble size chunks. Calcium carbonate found in joints.  GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf)			
COMMENTS: Surface vegetation consists of grasses and sage brush. Discontinued hole due to refusal on bedrock.					

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPPP7-16-4		SHEET 1 OF 1	
FEATURE: Pumping Plant 7		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Pumping Plant		GROUND ELEVATION: 6212.2			
COORDINATES: N 1,729,214 E 2,454,378		METHOD OF EXPLORATION: Deere 310k Backhoe			
APPROXIMATE DIMENSIONS: 8x16x10.4		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 6/6/2016		DATE EXCAVATED: 6/6/2016			
DEPTH ft.	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL  (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1 2 3 4	SC	0.0 to 4.1 ft CLAYEY SAND: About 70% fine sand; about 30% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; maximum size, fine sand; weak to strong reaction with HCl.  IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous. Calcium carbonate stringers present.  GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
4.1 ft (6208.1)					
5 6 7 8 9 10	SANDSTONE	4.1 to 10.4 ft SANDSTONE: Fine grained. Tan and light brown in color. Soft (H6), can be scratched with thumbnail and intensely weathered (W7). FeOx and MnOx staining present. Laminated to thinly bedded. No reaction with HCl. Excavated in flat, gravel to cobble size chunks. Calcium carbonate found in joints.  GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf)			
10.4 ft (6201.8)					
COMMENTS: Surface vegetation consists of grasses and brush. Discontinued hole due to refusal on bedrock.					

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Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPPP7-16-5		SHEET 1 OF 1	
FEATURE: Pumping Plant 7		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Pumping Plant		GROUND ELEVATION: 6213.8			
COORDINATES: N 1,729,101 E 2,454,289		METHOD OF EXPLORATION: Deere 310k Backhoe			
APPROXIMATE DIMENSIONS: 8x16x9.7		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 6/6/2016		DATE EXCAVATED: 6/6/2016			
DEPTH ft.	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL  (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1 2 3 4 4.5 ft (6209.3)	SC	0.0 to 4.5 ft CLAYEY SAND: About 65% fine sand; about 35% fines with low plasticity, low toughness, low dry strength and no dilatancy; maximum size, fine sand; no reaction with HCl.  IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous.  GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
5 6 7 8 9 9.7 ft (6204.1)	SANDSTONE	4.5 to 9.7 ft SANDSTONE: Fine grained. Tan and light brown in color. Soft (H6), can be scratched with thumbnail and intensely weathered (W7). FeOx and MnOx staining present. Laminated to thinly bedded. No reaction with HCl. Excavated in flat, gravel to cobble size chunks. Calcium carbonate found in joints.  GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf)			
COMMENTS: Surface vegetation consists of grasses and brush. Discontinued hole due to refusal on bedrock.					

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**Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design**

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPPP7-16-7</b>	SHEET 1 OF 1		
FEATURE: Pumping Plant 7		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Pumping Plant		GROUND ELEVATION: 6214.1			
COORDINATES: N 1,729,126 E 2,454,207		METHOD OF EXPLORATION: Deere 310k Backhoe			
APPROXIMATE DIMENSIONS: 8x16x10.4		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 6/7/2016		DATE EXCAVATED: 6/7/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
0 1 2 3 3.5 ft (6210.6)	SC	<p>0.0 to 3.5 ft CLAYEY SAND: About 70% fine sand; about 30% fines with low plasticity, low toughness, low dry strength and no dilatancy; maximum size, fine sand; strong reaction with HCl.</p> <p>IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous.</p> <p>GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)</p>			
4 5 6 7 8 9 10 10.4 ft (6203.7)	SANDSTONE	<p>3.5 to 10.4 ft SANDSTONE: Fine grained. White, light brown, tan and orange in color. Soft (H7) and can be scratched the thumbnail. Decomposed (W9) to intensely weathered (W7). Friable and is excavated in flat, gravel to cobble sized pieces. Laminated to thinly bedded. FeOx staining present. Calcium carbonate intervals throughout the unit. No to strong reaction with HCl.</p> <p>GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf)</p>			
COMMENTS: Surface vegetation consists of grasses and brush. Discontinued hole due to refusal on bedrock.					

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**Technical Memorandum No. ZN-8314-6  
Pumping Plant 7 – Geotechnical Design**

7-1336-A (1-86) Bureau of Reclamation		<b>LOG OF TEST PIT NO. TPPP7-16-8</b>		SHEET 1 OF 1	
FEATURE: Pumping Plant 7		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Pipeline		GROUND ELEVATION: 6215.7			
COORDINATES: N 1,728,992 E 2,454,182		METHOD OF EXPLORATION: Deere 310k Backhoe			
APPROXIMATE DIMENSIONS: 8x16x10.3		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 6/7/2016		DATE EXCAVATED: 6/7/2016			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	SC	0.0 to 3.4 ft CLAYEY SAND: About 65% fine sand; about 35% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; maximum size, fine sand; strong reaction with HCl.  IN-PLACE CONDITION: Dry, brown, moderate cementation and homogeneous.  GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
3.4 ft (6212.3)					
4	s(CL) (lab classification)	3.4 to 8.7 ft SANDY LEAN CLAY: About 60% fines with medium plasticity, medium toughness, high dry strength and no dilatancy; about 40% fine sand; maximum size, fine sand; weak to strong reaction with HCl.  IN-PLACE CONDITION: Dry, brown, gray and orange in color. Mottled and blocky. Very hard. FeOx staining and calcium carbonate present.  IN-PLACE UNIT WEIGHT AND MOISTURE FROM 7.0 ft. Total: 113.8 lbf/ft <sup>3</sup> ; 9.7% (107.2% compaction) LAB TEST DATA: 68.5% fines, 31.5% sand, LL = 34.7 PI = 20.5 SPG = 2.69 Maximum dry density: 106.2 lbf/ft <sup>3</sup> , optimum water content = 17.7% Laboratory classification is SANDY LEAN CLAY  GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
5					
6	In-place density taken at 7.0 ft				
8.7 ft (6207.0)					
9	SANDSTONE	8.7 to 10.3 ft SANDSTONE: Fine grained. Tan and light brown in color. Soft (H6), can be scratched with thumbnail and intensely weathered (W7). FeOx staining present. Laminated to thinly bedded. No reaction with HCl. Excavated in flat, gravel to cobble size chunks. Calcium carbonate found in joints.  GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf)			
10.3 ft (6205.4)					
COMMENTS: Surface vegetation consists of grasses, weeds and brush. Discontinued hole due to refusal on bedrock.					

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END OF SECTION

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