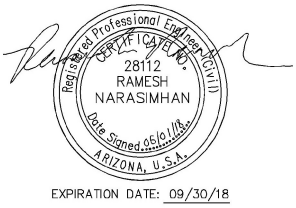
ANETH AND MONTEZUMA CREEK
ARSENIC TREATMENT FACILITIES

TECHNICAL SPECIFICATIONS (DIVISIONS 1 TO 17)
BID DOCUMENTS

June 2018



EXPIRATION DATE: 09/30/18

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DIVISION 1

GENERAL REQUIREMENTS

SECTION 01030

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Identification and summary description of the Project, the Work, location, OWNER furnished equipment, Work by OWNER, activities by others, and coordination.

B. The Project consists of construction of water treatment facilities (ATFs) at two well sites - Montezuma Creek (MC) Well 1 and MC Well 3.

1.02 THE WORK

A. The Work consists of construction of water treatment facilities including packaged arsenic/iron removal filters, backwash holding tanks, recycle pump stations, sludge holding tanks, pre-cast concrete buildings and other related appurtenances at two well sites - MC Well 1 and MC Well 3.

1.03 LOCATION OF PROJECT

A. The MC wells are located in San Juan County. Refer to the Drawings for location of each well site.

1.04 OWNER FURNISHED EQUIPMENT

B. None.

1.05 WORK BY THE OWNER

A. None.

1.06 ACTIVITIES BY OTHERS

A. OWNER, utilities, and others may perform activities within Project area while the Work is in progress:
   1. Schedule the Work with OWNER, utilities, and others to minimize mutual interference.

B. Cooperate with others to minimize interference and delays:
   1. When cooperation fails, submit recommendations and perform Work in coordination with work of others as directed.

2. When the Work depends for proper execution or results upon work performed by others, inspect and promptly report apparent discrepancies or defects in work performed by others.
3. Assume responsibility for work performed by others, except for defects reported as specified in this paragraph and defects which may become apparent in work performed by others after execution of the Work.

1.07 OPERATION OF EXISTING FACILITIES

A. All work must be scheduled with the OWNER to avoid interference with existing facilities. Refer to Section 01040 for additional requirements:
   1. Provide temporary facilities and make temporary modifications as necessary to keep the existing facilities in operation during the construction period.
   2. Any damage to existing property/equipment must be replaced to original working conditions.
   3. All relocations of existing piping shall be completed first before other construction activities.

1.08 COORDINATION OF WORK

A. Maintain overall coordination of the Work:
   1. CONTRACTOR shall be solely responsible for coordination of all of the work. Supervise, direct and cooperate fully with all subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies and all others whose services, materials or equipment are required to ensure completion of the work within the Contract time.
   2. CONTRACTOR shall cooperate with and coordinate work with the work of any other contractors, utility service companies or OWNER's employees performing additional work related to the Project site.
   3. CONTRACTOR shall coordinate work with the work of others to assure compliance with schedules.
   4. CONTRACTOR shall attend and participate in all project coordination or progress meetings and report on the progress of all work and compliance with construction schedule.

1.09 POTABLE WATER SUPPLY PROTECTION

A. All materials of construction which may come into contact with drinking water shall conform to NSF International Standards 60 and 61.

1.10 PERMITS

A. CONTRACTOR shall include the cost for and obtain all construction related permits, except permits described in Paragraph 1.10.B. These permits include, but are not limited to:
   1. Necessary permits for discharge of hydrostatic test water and chlorinated water used to disinfect piping and equipment.

2. As necessary Storm Water National Pollutant Discharge Elimination System (NPDES) permit for construction operations.

B. OWNER will provide the construction permit from the Navajo Nation Environmental Protection Agency. CONTRACTOR hereby consents to the jurisdiction of the Navajo Nation in connection with all activities conducted pursuant to, in connection with, or directly affecting compliance with this Agreement or to which the provisions of the Navajo Nation Safe Drinking Water Act otherwise apply. This consent shall be effective when a permit is issued and may not be withdrawn. This consent shall extend to and be binding upon all successors, heirs, assigns, employees and agents, including contractors and subcontractors, of the applicant. Navajo Nation Environmental Protection Agency (EPA) will conduct periodic site visits and a final inspection when construction is completed.

C. Building permits will not be issued to CONTRACTOR.

D. At time of substantial completion, CONTRACTOR shall contact the Navajo Nation Fire and Rescue Fire Chief to schedule fire inspection. Phone (928) 871-6915.

E. A certificate of occupancy will not be issued for the Project.

1.11 CONTRACTOR'S USE OF PREMISES

A. CONTRACTOR shall limit his use of the premises for Work and storage, and allow for work by other contractors/subcontractors. See Drawings for CONTRACTOR staging area(s).

B. CONTRACTOR assumes full responsibility for the protection and safekeeping of products and materials CONTRACTOR has stored on the site.

C. CONTRACTOR shall move any stored products, or materials, under CONTRACTOR's responsibility, which interfere with operations of OWNER and separate contractors/subcontractors.

D. CONTRACTOR shall obtain and pay for the use of any additional storage or work areas if needed for CONTRACTOR's operations.

E. CONTRACTOR shall be solely responsible for the location/identification of materials storage, equipment storage, and employee and subcontractor parking areas, subject to the approval of the OWNER.

F. CONTRACTOR shall restore any areas used for materials storage, equipment storage, or employee and subcontractor parking to their original condition or better, unless specified otherwise.

1.12 MAINTENANCE OF TRAFFIC

A. Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

B. Do not close any public street or portion thereof without first notifying and receiving approval from the local Fire Department and Police Department. Conduct operations to minimize interference with emergency vehicle access.

C. Traffic Control:
   1. Adequate barricades and lighted warning signs shall be installed and maintained by the CONTRACTOR throughout the duration of the Work.

1.13 PROJECT SIGN

A. At each of the project sites, provide a 4' x 8' plywood sign mounted on two 4" x 4" wood posts. The information to be provided on the sign and location of the sign will be provided by the ENGINEER.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01040

ORDER OF CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Order of construction activities to allow the OWNER normal operation of the existing facilities located on all the Project sites.

B. Related Sections include, but are not necessarily limited to:
1. Division 1.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

A. Milestone Dates - The construction duration to reach substantial completion shall not exceed 300 calendar days. CONTRACTOR shall also comply with the following interim dates of completion:

Task	**Interim Completion Date (days after notice to proceed)**
Construct Concrete Foundation for Buildings	90
Install Civil/Site and Yard Piping	120
Install Equipment and Process Piping	180
Install Prefabricated Concrete Building	240
Initiate Commissioning of the Arsenic Treatment Facilities	270

1. CONTRACTOR shall include sufficient and complete overhead costs in base Bid for a 300 calendar day construction duration to reach substantial completion. No change orders or claims for extended overhead will be considered unless the actual duration to reach substantial completion exceeds 300 calendar days:
a. No credit or refund will be given to CONTRACTOR if the work is substantially completed sooner than 300 calendar days.

B. Tie-ins shall be coordinated with the OWNER and shall be scheduled as to minimize the disruption of services:

1. Thirty calendar days before start of tie-ins between new and existing facilities and shutdown of facilities, CONTRACTOR shall provide a written proposed maintenance of plant operation (MOPO) for tie-in activities and shutdowns for review by the OWNER.
2. At no time shall CONTRACTOR or his employees modify operation of the existing facilities or start construction modifications without approval of the OWNER.
3. CONTRACTOR shall plan his work to allow OWNER access to existing facilities to perform maintenance and repair work.
4. Operation of existing valves shall only be performed by OWNER's personnel.

C. The following is a suggested construction sequence for the project which the CONTRACTOR should consider in developing his overall plan of construction. This is not intended to release the CONTRACTOR from the responsibility to coordinate the work in any manner which shall insure project completion within the time allowed:

1. Construct the concrete foundation for the buildings
2. Install process equipment and piping, including yard piping.
3. Install the precast concrete buildings on the concrete foundations and install necessary piping, equipment, etc. associated with the building.
4. Install the electrical and instrumentation and controls (I&C) from the treatment facilities and the existing well controls.
5. Conduct point to point and loop check for instrumentation and controls.
6. Perform commissioning of the treatment facility.
6. Conduct training of OWNER's staff.
7. Complete sitework and punchlist items.
8. Clean facilities.

END OF SECTION

SECTION 01060

SPECIAL CONDITIONS

PART 1 GENERAL

1.01 CONTRACTOR'S FIELD OFFICE AND STORAGE TRAILERS

A. Establish at site of Project subject to approval of OWNER.

B. Remove field office and storage trailers from site upon acceptance of the entire Work by the OWNER.

C. Maintenance:
   1. CONTRACTOR shall provide all weekly maintenance and upkeep of trailer and equipment. Equipment breakdowns shall be repaired promptly by CONTRACTOR.
   2. Pay all utilities costs.
   3. Maintain at least until acceptance of the entire Work by the OWNER or until otherwise suspended by the OWNER.

D. The field office shall be of adequate size and finished with table and chairs to host project meetings.

1.02 ENGINEER/OWNER FIELD OFFICE

A. At Montezuma Creek Well Site 2, CONTRACTOR shall provide office space within the CONTRACTOR's field office for the sole use of the ENGINEER/OWNER. The office shall be a minimum 100 square feet (within trailer).

B. Office shall include:
   1. Air conditioning and heating system.
   2. Fluorescent type lamps.
   3. Desk.
   4. 4 chairs.
   5. 3'-0"x6'-0" table.

C. Maintenance:
   1. CONTRACTOR shall provide all weekly maintenance and upkeep of trailer and equipment. Equipment breakdowns shall be required promptly by CONTRACTOR.
   2. Pay all utilities costs.
   3. Maintain at least until acceptance of the entire Work by the OWNER or until otherwise suspended by the OWNER.

1.03 SITE MAINTENANCE AND TEMPORARY PAINTING

A. Paint and maintain in good repair temporary structures, fences, barricades and related items.

B. Keep site clean of debris. Store and stockpile materials in an orderly manner and protect against damage.

1.04 TESTING

A. CONTRACTOR shall pay for all materials testing as required in the Contract Documents:
   1. Soils, rebar, and concrete testing: The CONTRACTOR shall retain a materials testing firm for soils, rebar, and concrete testing for the work. Cost of all tests, including` corrective action, costs of "failing" tests, and cost of testing associated with establishment of mix designs are the sole responsibility of the CONTRACTOR.
   2. Other testing: Unless specifically stated otherwise in individual sections of specifications or Drawings, required testing, testing procedures, reports, certificates, and costs associated with all phases of securing required satisfactory test information which may be required by individual sections of specifications or Drawings is the full responsibility of the CONTRACTOR.
   3. Testing performed by OWNER shall include microbiological sampling and testing of water samples from disinfection tests, and water quality testing during commissioning.

B. Qualifications of Laboratory:
   1. Where applicable, the testing laboratory shall meet "Recommended Requirements for Independent Laboratory Qualification," latest edition, published by American Council of Independent Laboratories and the basic requirements of ASTM E329 "Standard of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used on Construction."
   2. Testing equipment used by the laboratory shall be calibrated at maximum twelve (12) month intervals by devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.
   3. Limited Authority of Testing Agency: Any testing agency or agencies and their representatives retained by CONTRACTOR for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve, or accept any portion of the Work.

C. Laboratory Duties:
   1. The testing laboratory shall:

a. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
b. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with the requirements of Contract Documents.
c. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies of Work which are observed during performance of services.
d. Promptly submit copies of reports of inspections and tests to CONTRACTOR, OWNER, and ENGINEER including:
    1) date issued
    2) project title and number
    3) testing laboratory name and address
    4) date of inspection or sampling
    5) record of temperature and weather
    6) date of test
    7) identification of product and Specifications Section
    8) location in Project
    9) Name of structures if appropriate
    10) type of inspection or test
    11) results of tests and observations regarding compliance with Contract Documents

D. CONTRACTOR'S Responsibilities:
1. CONTRACTOR shall:
    a. Cooperate with laboratory personnel and provide access to Work and to manufacturer's operations.
    b. Provide to laboratory, preliminary representative samples of materials to be tested, in required quantities.
    c. Furnish copies of product test reports.
    d. Provide to laboratory the preliminary design mix proposed for concrete and other material mixes that require testing by the testing laboratory.
    e. Furnish labor and facilities:
        1) To provide access to Work to be tested.
        2) To obtain and handle samples at the site.
        3) To facilitate inspections and tests.
        4) For Laboratory's exclusive use for storage and curing of test samples.
        5) Forms for preparing concrete test beams and cylinders.
    f. Notify laboratory and OWNER 24 hours in advance of operations to allow for assignment of personnel and scheduling of tests.
    g. Arrange with laboratory and pay for additional samples and tests required for CONTRACTOR's convenience.

h. Meet with laboratory field technician during each field visit to confirm correct material parameters, site, test location, and project name is reflected on test report.

1.05 PROJECT MEETINGS

A. The OWNER/ENGINEER shall conduct a preconstruction conference and progress meetings involving:
   1. CONTRACTOR's Project Manager.
   2. CONTRACTOR's Project Superintendent.
   3. OWNER's designated Representative(s).
   4. ENGINEER's designated Representative(s).
   5. CONTRACTOR's Subcontractors as appropriate to the work in progress.

B. Progress meetings will be held bi-weekly at the field office trailer.

C. The ENGINEER shall take meeting minutes and distribute copies of meeting minutes to the designated recipients. Corrections, additions or deletions to the minutes shall be noted and distributed as required.

D. The CONTRACTOR shall have available at each meeting up-to-date red line as-built drawings.

1.06 SPECIAL CONSIDERATIONS

A. CONTRACTOR shall be responsible for negotiations of any waivers or alternate arrangements required to enable transportation of materials to the site.

1.07 CONSTRUCTION SCHEDULE AND WORK HOURS

A. The CONTRACTOR shall prepare a construction schedule:
   1. The CONTRACTOR shall submit a complete computer software generated critical path method schedule (CPM) to the OWNER at the pre-construction meeting (Primavera or approved equal). This schedule shall include a complete critical path schedule to cover the CONTRACTOR's anticipated time schedule.
   2. The schedule shall include a detailed network diagram acceptable to the OWNER with the following features:
      a. The schedule shall be time-scaled in calendar days.
      b. The schedule shall show the order and interdependence of activities and the sequence of work as reflected in the schedule report as described below. The critical activities shall be prominently distinguished.
      c. The schedule shall include, in addition to all construction activities, such tasks as mobilization and demobilization, submittal and

approval of samples of materials and shop drawings, procurement of significant materials and equipment, fabrication of special items, installation, startup, site work, cleanup, and interfacing with other projects/contractors/utility companies, etc.

d. The schedule diagram shall be organized and described as to conform to the schedule of values.

e. The diagram shall be accompanied by a schedule report of the network with a tabulation of the following data for each activity:
   1) preceding and following event numbers
   2) activity description
   3) activity duration
   4) earliest start date
   5) earliest finish date
   6) latest start date
   7) latest finish date
   8) total float time
   9) responsibility for activity (for example, CONTRACTOR, subcontractor, supplier, etc.)

3. The CONTRACTOR shall provide updated schedules and reports every month commencing from notice to proceed in conformation with the following:
   a. The OWNER or ENGINEER shall determine if the detailed network diagram and/or report requires revision in whole or in part, and shall so inform the CONTRACTOR of noncompliance with Contract schedule within 5 calendar days.
   b. The report shall show the activities or portion of activities completed during the one month period and the portion completed on the project to date; actual start and finish dates shall be shown plus future activities for the next four week period.
   c. The report shall state the percentage of revenue actually earned as of the report date.
   d. The report shall be accompanied by a narrative description of progress, problem areas, and current and anticipated delaying factors and their anticipated effect, and any correction actions proposed or taken. This report shall identify departures from earlier schedules or changes in logical sequence or logical ties.
   e. The report shall include a summary of all activities scheduled to begin in the next four week period that are critical path, those activities whose float had changed and those activities with less than the ten day float. The activities shall be sequenced by critical path activities, by least total float and by greatest float respectively.
   f. The CONTRACTOR shall use computer generated critical path scheduling software.

4. At each progress meeting the CONTRACTOR shall provide a two week look ahead schedule.

5. Acceptance of the CONTRACTOR's schedule by the OWNER is not to be construed as relieving the CONTRACTOR of its obligation to complete the Contract work within the Contract time.

B. The CONTRACTOR shall plan construction activities between normal work hours (6:00 a.m. to 6:00 p.m.) Monday through Friday excluding National holidays:
   1. Work hours outside these hours including Saturday may be permissible provided a construction schedule has been prepared, submitted to, and found acceptable to the OWNER. Work hours on Saturday shall be between 6:00 am to 6:00 pm.
   2. The schedule shall identify the Work to be performed, including the location and duration of planned activities.
   3. Submittals shall be made a minimum of seven days prior to the planned work to allow sufficient time for the OWNER and to review the request and schedule any necessary inspections.
   4. The CONTRACTOR shall be responsible for payment for all overtime and off-hours inspection for ENGINEER and testing that occur outside the normal and expected working hours indicated above.

1.08 SITE SECURITY

A. CONTRACTOR shall provide secure temporary fencing around the entire construction area including staging area with gate and lock. Integrity of fence shall be maintained throughout construction.

B. CONTRACTOR shall store small equipment and tools in secure, locked storage containers at the end of the work day.

C. CONTRACTOR assumes all risk associated with leaving construction materials, tools, vehicles, and equipment on site. OWNER is not liable for any damages or theft.

1.09 EXISTING SITE ACCESS ROADS

A. The existing access road to all the well sites is graded soil. The CONTRACTOR shall maintain the existing roads to the well sites during construction by blading the surface as conditions warrant, as often as needed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01072

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Prepare and maintain record documents for the project to accurately reflect the construction work as built. The record documents must be submitted at completion of the construction work as a condition of final acceptance of the Work by the OWNER.

1.02 MAINTENANCE OF RECORD DOCUMENTS

A. The CONTRACTOR shall maintain at the project site one copy each of the following record documents:
   1. Contract Drawings.
   2. Specifications.
   3. Design addenda.
   4. Reviewed shop drawings.
   5. Contract Change Orders and field orders.
   6. Supplemental drawings and written material provided by the ENGINEER to clarify the Contract Documents.
   7. Other contract modifications.
   8. Approved samples and/or sample results.

B. The CONTRACTOR shall store the project record documents in an approved location apart from other documents. Record documents are not to be used for construction purposes. The CONTRACTOR shall provide files and racks as needed for orderly storage of the documents, maintain the documents in clean, dry, legible condition, and make the documents and samples available at all times for inspection by the ENGINEER.

1.03 MARKING DEVICES

A. Mark all changes with red pencil or pen.

1.04 RECORDING

A. The CONTRACTOR shall keep the record documents current with construction in progress. Completed construction work shall not be permanently concealed until required information has been recorded.

B. The CONTRACTOR shall provide a rubber stamp for use in marking all project record documents. The stamp shall have a line border of approximately 4" x 1" with the words "PROJECT RECORD" printed inside the border.

C. The CONTRACTOR shall neatly stamp, in red, each record document "PROJECT RECORD", and legibly mark the Contract Drawings to record actual construction deviations as follows:
   1. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
   2. Field changes of dimension and detail.
   3. Changes made by design addenda, change order or field order.
   4. Details not on original Contract Drawings.

D. The red line as-builts shall also include buried conduit in yard.

1.05 SUBMITTAL

A. Red line record drawings shall be available for review by the ENGINEER whenever an application for a monthly progress payment is made. The partial record drawings shall be up-to-date through the end of the progress payment application period.

B. At completion of construction, and prior to the final inspection and final acceptance of the project by the OWNER, the CONTRACTOR shall deliver the project record documents to the ENGINEER bound into rolls of convenient size for ease of handling and properly labeled.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01210

CONTINGENCY ALLOWANCES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes administrative and procedural requirements governing contingency allowances.

1.02 CONTINGENCY ALLOWANCES

A. Contingency allowances are stipulated amounts available as a reserve for sole use by OWNER.

B. When OWNER authorizes use of funds from the contingency allowances, submit Change Order request to ENGINEER. Prepare Change Order request in accordance with the provisions of the General Conditions.

C. The bond and insurance amounts for the total contingency allowance amount shall be included in the base Bid.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SCHEDULE OF ALLOWANCES

A. Allowances:
   1. Include a contingency for field testing of locally processed or provided materials. CONTRACTOR to provide invoices from the materials testing firm to receive reimbursement from OWNER. CONTRACTOR will not be allowed profit and overhead on these costs.
   2. Include a contingency allowance for miscellaneous construction in accordance with OWNER's instructions.

END OF SECTION

SECTION 01331

REFERENCE FORMS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section contains the forms for CONTRACTOR to use in documenting Work required under this Contract. CONTRACTOR may use an alternative form if approved by ENGINEER that contains the required information and is in a similar format.

B. The forms listed below may be referenced from other Sections in the Contract Documents. Forms will include, but will not be limited to the following:

No.	Form Title
1.	Request for Change Order Proposal
2.	Change Order Proposal
3.	Request for Information
4.	Contractor's Daily Construction Report
5.	Field Order
6.	Work Change Directive
7.	Shop Drawing Transmittal (See Section 01340)

C. Also refer to Bid Documents for additional OWNER forms.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

REQUEST FOR CHANGE ORDER PROPOSAL

Date: _____

Contractor:_____

Project Name: Montezuma Creek Arsenic Treatment Facilities
Navajo Tribal Utility Authority

Request for Change Order Proposal No. _____

NOTICE TO CONTRACTOR: Please submit a Change Order Proposal for the proposed modifications to the Contract Documents as described below. If acceptable, a Change Order will be issued to authorize the work. THIS IS NOT A CHANGE ORDER FOR AUTHORIZATION TO PROCEED WITH THE WORK AS DESCRIBED!

SCOPE OF WORK:

_____
OWNER

CHANGE ORDER PROPOSAL

Date:_____

Contractor: _____

Project Name: Montezuma Creek Arsenic Treatment Facilities
Navajo Tribal Utility Authority

Project No.

Change Order Proposal No.:_____

Dear Sir:

Certain items of extra work have been found necessary which are not covered by the Contract for the above referenced Project. Therefore, we submit the following amounts as the basis of compensation for such extra work:

JUSTIFICATION:

The Contract Time will be (increased)(decreased) _____ calendar days.

The Contract Amount will be (increased)(decreased) $_____ dollars.

By:_____

Title:_____

Contractor:_____

REQUEST FOR INFORMATION

Montezuma Creek Arsenic Treatment Facilities

Contractor _____	RFI#_____
Requested By _____	Directed to _____
Subject _____	Date Received _____
Spec. Section _____	Date Transmitted _____
Drawing References _____	Date Reply Received _____
Date Reply Needed _____	Date Reply Transmitted _____

INFORMATION NEEDED:

Date:_____ Signature: _____

REPLY:

Date:_____ Signature:_____

CONTRACTOR'S DAILY CONSTRUCTION REPORT

Project Name: Navajo Tribal Utility Authority, Montezuma Creek

Contractor's Name _____ Report No. _____ Date: _____

CONTRACTORS WORK FORCE:	SUBCONTRACTORS WORK FORCE:	EQUIPMENT ON SITE:
Administrative		In Use / Not in Use
Supervisors	Mechanical	Cranes
Carpenters	Electrical	Loaders
Iron Workers	Instrumentation	Dozers
Operators	Sitework	Scrapers
Finishers	Masonry	Compactors
Welders	Roofing	Compressors
Electricians	Rebar	Welders
Laborers	Foundation	Graders
_____	Painting	Trucks
_____	_____	Backhoe
_____	_____	___
	_____	

Work Performed:

Material and Equipment Delivered:

Remarks:

_____
(Authorized Signature)

FIELD ORDER

Date: _____

Contractor:_____

Project Name: Montezuma Creek Arsenic Treatment Facilities
Navajo Tribal Utility Authority

Field Order No.: _____

By:_____ By_____
Owner's Authorized Signature Contractor's Receipt Acknowledged

Date:_____ Date:_____

WORK CHANGE DIRECTIVE

No. _____

PROJECT: Navajo Tribal Utility Authority, Montezuma Creek Arsenic Treatment Facilities

DATE OF ISSUANCE _____ EFFECTIVE DATE _____

OWNER: Navajo Tribal Utility Authority

CONTRACTOR:

You are directed to proceed promptly with the following change(s):

Description:

Purpose of Work Change Directive:

Attachments: (List documents supporting change)

If a claim is made that the above change(s) have affected Contract Price or Contract Times, any claim for a Change Order based thereon will involve one or more of the following methods of determining the effect of the change(s).

Method of determining change in Contract Price:

- ☐ Unit Prices
- ☐ Lump Sum
- ☐ Other _____

Estimated increase (decrease) in Contract Price: $_____
If the change involves an increase, the estimated amount is not to be exceeded without further authorization.

Method of determining change in Contract Times:

- ☐ Contractor's records
- ☐ OWNER's records
- ☐ Other _____

Estimated increase (decrease) in Contract Times: Substantial Completion: ___ days
Ready for final payment: ___ days
If the change involves an increase, the estimated time is not to be exceeded without further authorization.

AUTHORIZED:

_____
OWNER

By: _____

SECTION 01340

TECHNICAL SUBMITTALS
SHOP DRAWINGS, PROJECT DATA & SAMPLES, OPERATION AND MAINTENANCE MANUALS, EQUIPMENT RECORD SHEETS

PART 1 GENERAL

1.01 SUMMARY

A. General:
   1. Section Addresses:
      a. Mechanics of shop drawing and operation and maintenance manual submittal and review process.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Sections in Divisions 2 through 16 identifying submittal requirements.

1.02 SUBMITTALS: GENERAL

A. Transmit all technical submittals electronically to:

Sriram Barigeda (or other designated representative)
Sriram@ncseng.com (Or upload to project dropbox folder)

For those larger items that require hard copies, send to following address:

NCS Engineers
202 E. Earll Drive, Suite 110
Phoenix, AZ 85012

B. Utilize one copy of "Contractor's Shop Drawing Transmittal" (Exhibit A-01340) Form to transmit all shop drawings, Operation and Maintenance Manuals, and samples. Transmittals will not be received from or returned to subcontractors.

C. Provide submittal information defining specific equipment or materials utilized on the project. Generalized product information not clearly defining specific equipment or materials to be provided will be rejected.

D. Calculations required in individual specification sections will be received for information purposes only and will be returned stamped "E". Engineer's Review Not Required" to acknowledge receipt.

E. Assure submittals meet the following schedule:
   1. Shop drawings:
      a. Submittal and approval prior to that portion of work being installed and prior to 50 percent overall completion.
      b. ENGINEER will attempt to return all submittals to CONTRACTOR within 14 calendar days of receipt.
   2. Operation and Maintenance Manuals and Data Record Sheets:
      a. Initial submittal within 45 days after date shop drawings are approved.

F. Final payment on the project shall not be made until final approved copies of all Operation and Maintenance Manuals have been received.

G. Provide CONTRACTOR's stamp of approval as indication of his checking and verification of dimensions and coordination with interrelated work.

H. Provide schedule of submittals with anticipated submittal dates within two weeks after the preconstruction conference.

1.03 SUBMITTALS: SHOP DRAWINGS

A. Transmittal Mechanics:
   1. Utilize one copy of "Contractor's Transmittal" Form.
   2. Number transmittals consecutively beginning with 1.
   3. Assure resubmitted items retain the original number but with an added suffix letter starting with "A".
   4. Assure only one specification section is covered by one letter of transmittal.
   5. Provide breakout of each transmittal component on the "Contractor's Transmittal" Form. Each component thus defined shall receive specific action by the ENGINEER. Define manufacturer, item, tag number, and Drawing/Specification reference, as applicable.
   6. Do not change the scope of any re-submittal from the original transmittals' scope. If some components of the original transmittals are approved and others are not, the CONTRACTOR shall not resubmit the approved components in subsequent re-submittal packages, unless requested to do so by ENGINEER. Provide a summary sheet containing all components of the original transmittal at the front of each re-submittal. Indicate each component as either "approved", outstanding", or "submitted for action". Items previously approved shall be referenced to the transmittal in which approval was received. "Outstanding" items are defined as items unapproved and not yet resubmitted for action. "Submitted for action" shall indicate items which are included for review in the transmittal.
   7. Provide submittal in pdf format and transmit to ENGINEER via email for review.

8. Provide clear space (3 inch square) for ENGINEER stamping of each component.
9. ENGINEER will return reviewed submittal in pdf format via email.

B. Transmittal Contents:
1. Coordinate and identify shop drawing contents so that all items can be easily verified by the ENGINEER.
2. Identify equipment or material use, tag number, drawing detail reference, weight, and other project specific information.
3. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.
4. Submit items like equipment brochures, cuts of fixtures, product data sheets or catalog sheets on 8½ x 11 inch pages. Indicate exact item or model and all proposed options.
5. Larger sheets (11"x17" or 24"x36") should be folded into smaller sections and sent by hard copy, if needed.
6. Include legible scale details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout drawings, parts catalogs, rough-in diagrams, wiring diagrams, controls weights and other pertinent data. Arrange data and performance information in format similar to that provided in Contract Documents. Provide, at minimum, the detail provided in the Contract Documents.
7. If proposed equipment or materials deviate from the Specifications or Drawings in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet. If explanation is not given, shop drawings will be returned without action.
8. Provide copy of applicable specification section annotated in red to indicate that all requirements have been met with the shop drawing.

1.04 SUBMITTALS: SAMPLES

A. Identify sample as to: manufacturer, item, use, type, project designation, tag number, specification section or drawing detail reference, color, range, texture, finish and other pertinent data.

B. Include application specific brochures, and installation instructions.

C. Provide CONTRACTOR’s stamp of approval on samples as indication of his checking and verification of dimensions and coordination with interrelated work.

D. Resubmit samples of rejected items.

E. Approved samples submitted or constructed, constitute criteria for judging completed work. Finished work or items not equal to samples will be rejected.

F. Samples may be retained for comparison purposes and the CONTRACTOR shall remove samples when directed. CONTRACTOR shall include in bid all costs of furnishing and removing samples.

1.05 SUBMITTALS: OPERATION AND MAINTENANCE MANUALS

A. Transmittal Mechanics:
   1. See Paragraph 1.02 and 1.03.
   2. Provide transmittal form for Operation and Maintenance Manual with original number of the shop drawing approved item plus a suffix "O-M".
   3. Submit one copy until approval is received.
   4. Provide complete electronic copies of the entire O&M manual in pdf format. The entire O&M manual information for each specification section shall be included in a single PDF. Each PDF shall be appropriately labeled. This is required for all O&M manuals associated with this Project. All pdf sections shall be combined into a single pdf with an indexed table of contents for the entire O&M manual. Each section pdf shall be book marked to the table of contents. Place on a CD and provide two copies of the CD.
   5. Deficient submittals will be returned along with transmittal form which will be marked to indicate deficient areas.
   6. Identify resubmittals with the original number plus a suffix letter starting with "A."
   7. Submit hard copy of Final Operation and Maintenance Manuals (3 copies) printed on 8-½" x 11" inch size high quality paper with standard three-hole punching and bound in stiff metal hinged binder constructed as a three-post style. Provide binders with titles. Tab each section of manuals for easy reference with plastic-coated dividers. Provide index for each manual.
   8. Reduce drawings or diagrams bound in manuals to an 8½" x 11" inch or 11" x 17" inch size. However, where reduction is not practical to ensure readability, fold large drawings separately and place in vinyl envelopes which are bound into the binder. Identify vinyl envelopes with drawing numbers.

B. Transmittal Content:
   1. Submission of Operation and Maintenance Manuals is applicable to but not necessarily limited to:
      a. Equipment such as meters, valves, pumps and feed system controls, electrical panels, and instrumentation.
      b. Equipment used with electrical motor loads (pumps).
      c. Specialized equipment including valves and instrumentation and control system components for process systems such as meters, recorders, and transmitters.
      d. Valves and actuators.
   2. Prepare operation and maintenance manuals which include, but are not necessarily limited to the following detailed information, as applicable:

a. Equipment function, normal operating characteristics, limited operations.
b. Assembly, disassembly, installation, alignment, tolerances, adjustment, and checking instructions.
c. Operating instructions for start-up, routine and normal operation, regulation and control, shutdown, and emergency conditions.
d. Lubrication and maintenance instructions (including schedules).
e. Guide to “troubleshooting”.
f. Parts list (including material of construction) and predicted life of parts subject to wear.
g. Outline, cross-section, and assembly (exploded view) drawings; engineering data; and electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, word description of wiring diagrams and interconnection diagrams.
h. Test data and performance curves.
i. A list of recommended spare parts with a price list.
j. Copies of installation instructions, parts lists or other documents packed with equipment when delivered.
k. Tag numbers relating the equipment back to the Contract Documents.
l. Safety instructions.
m. ISO identification numbers for bearings.
n. List of specialty tools required and availability.
o. List weight of overall assemblies and individual weights of major individual components.
p. List of vendors and who to contact for warranty work.
q. List of fastener grades.
r. Copy of warranty, if applicable.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTALS: APPROVAL OR REJECTION

A. Items within Transmittals will be reviewed for overall design intent and will receive one of the following Actions:

A - NO EXCEPTIONS TAKEN
B - FURNISH AS NOTED
C - REVISE AND RESUBMIT
D - REJECTED
E - ENGINEER’S REVIEW NOT REQUIRED

B. Transmittals received will be initially reviewed to ascertain inclusion of CONTRACTOR's approval stamp. Drawings not stamped by the CONTRACTOR or stamped with a stamp containing language other than that specified in Paragraph 1.02 G will not be reviewed for technical content and will be returned without any action.

C. Transmittals returned with disposition "A" or "B" are considered ready for fabrication and installation. If for any reason a transmittal that has an "A" or "B" disposition is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal. The CONTRACTOR shall assure that previously approved documents are destroyed when they are superseded by a resubmittal as such.

D. Transmittals with disposition "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected), will be individually analyzed giving consideration as follows:

1. The portion of the transmittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference). One copy or the one transparency of the "C" or "D" drawings will be marked up and returned to the CONTRACTOR. It shall be the CONTRACTOR's responsibility to ensure that these items are corrected and resubmitted.
2. Items marked "A" or "B" will be fully distributed.
3. If a portion of the items or system proposed are acceptable, however, the major part of the individual drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" action. This is at the sole discretion of the ENGINEER. In this case, some drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package." Distribution to the OWNER, CONTRACTOR, and ENGINEER will not be made (unless previously agreed to otherwise).

E. Failure to include any specific information specified under the submittal paragraphs of the specifications shall result in the transmittal being returned to the CONTRACTOR unapproved.

F. In addition to calculations stamped and returned "E. Engineer's Review Not Required", other transmittals such as submittals which the Engineer considers as "Not Required" and submittal information in a transmittal which have been reviewed and approved in a prior transmittal, will be returned with action "E. Engineer's Review Not Required."

END OF SECTION

NCS

Shop Drawing Transmittal

Project Name:		Transmittal No.:
Project Location:		Date Received:
To: NCS Engineers 202 E. Earll Drive, Suite 110 Phoenix, AZ 85012 Attn:	From: Attn:	NCS Job No.: Reviewed By: Date Reviewed: Spec. Section:
Date Transmitted:	Previous Transmittal Date:	1st. Sub.☐ ReSub.☐

No. Copies	Description	Manufacturer	Drawing or Data No.	Action Taken*

Submitter's Remarks:

* The action Designated Above is in Accordance with the Following Legend:

A - No Exceptions Taken
B - Furnish as Noted
C - Revise and Submitt
1. Not enough information for review.
2. No reproducibles submitted.
3. Copies illegible
4. Not enough copies submitted.
5. Wrong sequence number.
6. Wrong resubmittal suffix.
7. Wrong specification section.
8. Wrong form used.
9. See comments.

D - Rejected
E - Engineer's review not required.
1. Submittal not required.
2. Supplemental information. Submittal retained for informational purposes only.
3. Information reviewed and approved on prior submittal.
4. See comments.

Reviewer's Comments:

Returned by (NCS) : Date:

Distribution:	Supplier (if applicable)	____ Copies	NTUA:	____ Copies
	Sub Consultant 1:	____ Copies	NCS:	____ Copies
		____	Sub Consultant 2:	____ Copies

SECTION 01350

SPECIAL PROCEDURES

PART 1 GENERAL

1.01 CONCEALED EXISTING FACILITIES

A. Verify locations of utilities and facilities which may exist by consulting with OWNER, Navajo Tribal Utility Authority, locate service at 1-800-528-5011:
   1. Abide by easement and right-of-way restrictions.

B. Notify owners of facilities when the Work will be in progress. Make arrangements for potential emergency repairs in accordance with requirements of owners of facilities including individual or residential facilities.

C. Assume responsibility for repair of facilities damaged by performance of the Work.

D. Expose sanitary and storm sewers, water, gas, electric, telephone utility lines, and other underground facilities indicated to permit survey of location and elevation prior to commencement of Work in affected area.

E. Expose in ample time to permit relocation of interfering utilities with minimum delaying effect on contract time.

F. Work required for raising, lowering, or relocating utilities in right of way not indicated will be performed by affected utility owners or as part of the Work at option of affected owners of utilities and OWNER.

1.02 PROTECTION OF THE WORK AND PROPERTY

A. CONTRACTOR shall assume responsibility for taking all precautions, providing all programs, and taking all actions necessary to protect the Work and all public and private property and facilities from damage as specified in the General Conditions and herein.

B. In order to prevent damage, injury or loss, CONTRACTOR'S actions shall include, but not be limited to the following:
   1. Store apparatus, materials, supplies, and equipment in an orderly, safe manner that will not unduly interfere with the progress of the Work or the Work of any other contractor or utility service company.
   2. Provide suitable storage facilities for all materials which are subject to injury by exposure to weather, theft, breakage, or otherwise.
   3. Place upon the Work or any part thereof only such loads as are consistent with the safety of that portion of the Work.

4. Clean up frequently all refuse, rubbish, scrap materials, and debris caused by CONTRACTOR's operations, to the end that at all times the site of the Work shall present a safe, orderly and workmanlike appearance.
5. Provide barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, elevated walkways and other hazardous areas.

C. CONTRACTOR shall not, except after written consent from proper parties, enter or occupy privately owned land with personnel, tools, materials or equipment, except on easements provided herein.

D. CONTRACTOR shall assume full responsibility for the preservation of all public and private property or facility on or adjacent to the site. If any direct or indirect damage is done by or on account of any act, omission, neglect or misconduct in the execution of the Work by the CONTRACTOR, it shall be restored by the CONTRACTOR, at his expense, to a condition equal to that existing before the damage was done.

E. Underground Structures:
1. Underground structures are defined to include, but are not limited to, all sewer, water, gas, and other piping, and manholes, chambers, electrical conduits, tunnels and other existing subsurface work located within or adjacent to the limits of the Work.
2. All underground structures known to ENGINEER, except water, gas, sewer, electric, and telephone service connections, are shown on Drawings. This information is shown for the assistance of CONTRACTOR, in accordance with the best information available, but is not guaranteed to be correct or complete.
3. CONTRACTOR shall explore ahead of trenching and excavation Work and shall uncover all obstructing underground structures sufficiently to determine their location, to prevent damage to them and to prevent interruption to the services which such structures provide. If CONTRACTOR damages an underground structure, restore it to original condition at his expense.
4. Necessary changes in the location of the Work may be made by the OWNER to avoid unanticipated underground structures.
5. If permanent relocation of an underground structure or other subsurface facility is required and is not otherwise provided for in the Contract Documents, OWNER will direct CONTRACTOR, in writing, to perform the Work, which shall be paid for under the provisions of the General Conditions.

F. Surface Structures: Surface structures are defined as all existing buildings, structures and other facilities above the ground surface. Included with such structures are their foundations or any extension below the surface. Surface structures include, but are not limited to, buildings, tanks, walls, roads, open drainage, piping, poles, wires, posts, signs, markers, curbs, walks and all other facilities that are visible above the ground surface.

G. Protection of Underground and Surface Structures:

1. CONTRACTOR shall sustain in their places and protect from direct or indirect injury all underground and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure. Before proceeding with the work of sustaining and supporting such structure, CONTRACTOR shall satisfy the OWNER that the methods and procedures to be used have been approved by the party owning same.
2. CONTRACTOR shall assume all risks attending the presence or proximity of all underground and surface structures within or adjacent to the limits of the Work. CONTRACTOR shall be responsible for all damage and expense for direct or indirect injury caused by his Work to any structure. CONTRACTOR shall repair immediately all damage caused by his work, to the satisfaction of the OWNER of the damaged structure.

H. All other existing surface facilities, including but not limited to guard rails, posts, guard cables, signs, poles, markers, and curbs, which are temporarily removed to facilitate installation of the Work, shall be replaced and restored to their original condition at CONTRACTOR's expense.

1.03 DAILY WORK REPORTS

A. CONTRACTOR shall provide to OWNER and ENGINEER one copy of his daily field report indicating work completed, number and classification of personnel on site, number and types of construction equipment on site and weather conditions. The field reports shall be in pdf format.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01414

EARTHMOVING AND DUST CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall obtain all earthmoving permits and any other permits required for earthmoving and dust generating operations related to the Work

B. CONTRACTOR shall not cause or allow any dust generating operation, earthmoving operation, use of property, or any other operation which causes fugitive dust emissions.

C. CONTRACTOR shall pay all fines issued to the OWNER by any government entity that are the result of the actions of the CONTRACTOR.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01423

REFERENCE STANDARDS

PART 1 GENERAL

1.01 SUMMARY

A. When a reference standard is specified, comply with requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following (It is noted that all of these may not apply but are listed for general reference information):

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Concrete Institute (ACI).
3. American Gear Manufacturers Association (AGMA).
4. American Institute of Steel Construction (AISC).
5. American Iron and Steel Institute (AISI).
6. American National Standards Institute (ANSI).
7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
8. American Society of Mechanical Engineers (ASME).
9. American Society for Testing and Materials (ASTM).
10. American Water Works Association (AWWA).
11. American Welding Society (AWS).
12. Concrete Reinforcing Steel Institute (CRSI)
13. Factory Mutual (FM).
14. Institute of Electrical and Electronics Engineers (IEEE).
15. National Electrical Manufacturer's Association (NEMA).
16. Occupational Safety and Health Administration (OSHA).
17. National Fire Protection Association (NFPA).
18. Underwriters' Laboratories, Inc. (UL).
19. All other applicable standards listed in the Specifications and the standards of utility service companies, where applicable.
20. NSF International (NSF).
21. State Division of Industrial Safety (DIS)
22. Institute of Makers of Explosives (IOMOE)
23. Enclosures for Industrial Controls and Systems (ICS)
24. (ISA) See 13329-3
25. National Association of Corrosion Engineers (NACE)

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Furnishing, maintaining, and removing construction facilities including temporary utilities, construction aids, barriers and enclosures, security, and removal after construction.
   1. Requirements are of concern to OWNER and are representative of construction facilities and controls which are solely CONTRACTOR's responsibility.
   2. No attempt is made to set out in detail means or methods necessary to satisfy requirements:
      a. Recognition of requirements is made to assist CONTRACTOR in the identification of necessary costs.

1.02 TEMPORARY UTILITIES

A. Temporary Electrical Power:
   1. CONTRACTOR is responsible for all costs of wiring, connections, and interface with Navajo Tribal Utility Authority Electrical Department for temporary power supply during construction.
   2. CONTRACTOR to:
      a. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
      b. Pay for electric power for performance of the Work.

B. Temporary Electrical Lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
   2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
      a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by CONTRACTOR for lighting.

C. Temporary Heating, Cooling, and Ventilating:
   1. As needed, heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers. Once buildings are enclosed, maintain a minimum temperature of 40°F.

D. CONTRACTOR to provide phone service for all his employees and subcontractors. CONTRACTOR will not be permitted to use OWNER's telephones.

E. Temporary Water:
   1. The CONTRACTOR may obtain construction water by accessing the water taps or hydrants at each site. Provide backflow preventer. CONTRACTOR shall advise NTUA of the estimated amount of construction water needed, and pay for a permit. CONTRACTOR shall request a hydrant meter and provide a $500 refundable payment. CONTRACTOR will be required to pay for all construction water on a set fee per thousand gallons. CONTRACTOR can contact NTUA at (800) 528-5011 for price information.
   2. Provide and remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.

F. Temporary Sanitary Facilities:
   1. Provide temporary sanitary facilities for the needs of all employees and workers at each of the sites.
   2. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
   3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

G. Temporary Fire Protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

H. First Aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

1.03 CONSTRUCTION AIDS

A. General:
   1. Use construction hoists, elevators, scaffolds, stages, shoring and similar temporary facilities of ample size and capacity to adequately support and move loads.
   2. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.
   3. Design temporary supports with adequate safety factor to assure adequate load bearing capability:
      a. When requested, submit design calculations by professional registered engineer prior to application of loads.
   4. Submitted design calculations are for information and record purposes only.

B. Accident Prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment, and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction Work, take necessary action to comply with provisions for safety and accident prevention.

C. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, other public or private areas, and on project site.

D. Warning Devices and Barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers.
   1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

E. Hazards in Public Right-of-Way:
   1. Mark at reasonable intervals, trenches and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
      a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
   2. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
      a. During hours of darkness, provide warning lights at close intervals.

F. Hazards in Protected Areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

G. Above Grade Protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

H. Protect existing structures, trees, shrubs, and other items to be preserved from injury, damage or destruction by vehicles, equipment, workers or other agents with substantial barricades or other devices commensurate with hazards.

1.04 REMOVAL

A. Remove temporary buildings and furnishings before inspection for Final Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions, unless noted otherwise.

D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01560

ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall perform all work in such manner as to minimize the polluting of air, water, or land, and shall, within reasonable limits, control noise and the storage of solid waste materials.

B. Work shall comply with requirements of Navajo Nation Environmental Protection Agency (NNEPA).

1.02 QUALITY ASSURANCE

A. Employ and utilize environmental protection methods, and obtain all necessary permits required at the site for air quality, solid waste, storm water pollution, and hazardous wastes. CONTRACTOR shall comply with all state, county, and Federal regulations.

1.03 SUBMITTALS

A. See Section 01340.

B. See Section 3.01.C.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 ERECTION AND INSTALLATION

A. Land Protection:
   1. Manage and control all work or storage areas, access routes and embankments to prevent sediment from entering nearby water or land adjacent to site of work.
   2. Restore all disturbed areas including haul areas and establish permanent type of locally adaptable vegetative cover.
   3. Unless earthwork is immediately paved or surfaced, protect all side slopes and backslopes immediately upon completion of final grading.
   4. Plan and execute earthwork in a manner to minimize duration of exposure of unprotected soils.

B. Erosion Protection:
   1. Utilize methods necessary to effectively prevent erosion and control of sediment and include the following:
      a. Retardation: Mechanically retard rate of runoff by construction of diversion ditches, terraces, and berms. Divert run off to protect damage courses.
      b. Borrow constraints: Do not borrow soils from areas where environmental controls are not possible.
      c. Protect side and backslopes as soon as rough grading is complete by accelerated growth of permanent vegetation, temporary vegetation, mulching or netting. Where slopes are too steep for stabilization, use hydroseeding, mulching anchored in placed, cover anchored in placed, cover by anchored netting, sodding, or combination to prevent erosion. Remove temporary protection prior to final grading.
   2. Comply with requirements of NPDES storm water regulations for construction sites and provide a storm water pollution prevention plan.
      a. The Contract Price shall include all material, labor, other permits and incidental costs relating to compliance with provisions of the NPDES Storm Water Regulations.

C. Prepare, submit, update and revise Stormwater Construction Pollution Prevention Plan (SWPPP):
   1. Installing and maintaining all structural and non-structural items chosen by CONTRACTOR to comply with the construction SWPPP:
      a. Clean-up and disposal costs associated with clean-up and repair following storm events or CONTRACTOR caused spills on the Project.
      b. Implementing and maintaining Best Management Practices to comply with stormwater regulations:
         1) Submit Notices of Intent and Termination to United States Environmental Protection Agency (EPA) and ENGINEER. Use EPA electronic NOI system to prepare and submit Notice of Intent and Termination. Use permit #AZR 12,000I to prepare the notices.
      c. All necessary SWPPP controls and practices must be implemented prior to commencement of any construction activity.
      d. CONTRACTOR shall submit to the OWNER, as part of the Construction SWPPP a construction site inspection report that includes the following:
         1) Inspection scope.
         2) Inspector qualifications.
         3) Observations of SWPPP non-compliance and corrective steps taken.

4) Certificate of Compliance with SWPPP in the event of no incidents. Reports shall be submitted each quarter, at a minimum, throughout the Contract duration.

e. Provide copy of all documents to OWNER and ENGINEER.

f. Post a sign or other notice conspicuously at a safe, public accessible location in close proximity to the project site. At a minimum, the notice must include the NPDES Permit tracking number and a contact name and phone number for obtaining additional project information. The notice must be located so that it is visible from the public road that is nearest to the active part of the construction site, and it must use a font large enough to be readily viewed from a public right-of-way.

D. Control of Responsibilities:

1. Collect and dispose of solid waste on a daily basis.
2. Provide disposal of degradable debris to an approved solid waste disposal site.
3. Provide disposal of nondegradable debris to an approved solid waste disposal site or in an alternate manner approved by OWNER and regulatory agencies.
4. Store chemical wastes in watertight containers and remove from project site and dispose of to sites approved by regulatory agencies. Assure maximum disposal frequency of one month.
5. Control dust at all times, including nonworking hours, weekends and holidays. Sprinkle site or treat with dust suppressors as necessary to control dust. Utilize methods and practices of construction to eliminate dust in full observance of regulatory agencies.
6. Minimize noise by fitting equipment with appropriate mufflers. The use of explosives or blasting operations are not approved.
7. On completion of work, leave area in a clean condition representative of current conditions. Assure all signs of temporary construction and activities incidental to construction of required permanent work in place are obliterated.

E. Historical Protection:

1. If during the course of construction evidence of deposits of historical or archaeological interests are found, cease work affecting find and notify the OWNER. Do not disturb deposits until written notice from OWNER is given to proceed. Lost time or changes in construction to avoid the find shall be compensated for based upon partial suspension of work.

END OF SECTION

SECTION 01600

PRODUCT DELIVERY, STORAGE AND HANDLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Scheduling of product delivery.
   2. Packaging of products for delivery.
   3. Protection of products against damage from:
      a. Handling.
      b. Exposure to elements or harsh environments.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.

C. Payment:
   1. No payment will be made to CONTRACTOR for equipment not properly stored and insured.
   2. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

1.02 QUALITY ASSURANCE

A. Manufacturer's written directions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Scheduling:
   1. Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.

B. Packaging:

1. Deliver products or equipment in manufacturer's original unbroken cartons or other containers, clearly and fully marked and identified as to manufacturer, item, installation location and instructions for assembly, use and storage.

C. Protection:

1. Protect all materials in accordance with manufacturer's written directions:
   a. Store products or equipment in location to avoid physical damage to items while in storage.
   b. Handle products or equipment in accordance with manufacturer's recommendations and instructions.
2. Protect equipment from exposure to elements and keep thoroughly dry. Store pumps, motors, electrical equipment, and other equipment having antifriction or sleeve bearings in weathertight warehouses which are maintained at a temperature of at least 60 deg. F.
3. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to satisfaction of OWNER.
4. Protect electrical equipment, controls, and insulation against moisture or water damage.

3.02 FIELD QUALITY CONTROL

A. Inspect all products or equipment delivered to the site prior to unloading and reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.

B. Continually monitor storage area to ensure suitable temperature and moisture controls are maintained.

END OF SECTION

SECTION 01610

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Description of applicable codes, ordinances, and regulations.

1.02 CODES AND ORDINANCES

A. Applicable Codes: Compliance with all laws, ordinances, and regulations of authorities having jurisdiction is an integral requirement of the Contract Documents, whether each code is mentioned or not in the Contract documents.

B. Compliance: Comply with all applicable codes, ordinances and regulations in effect at the time of bid opening, including but not necessarily limited to the following:

1. 2018 International Building Code.
2. 2017 National Electrical Code.
3. 2018 International Plumbing Code.
4. 2018 International Mechanical Code.
5. 2018 International Fire Code.
6. National Fire Protection Association Standards.
7. Utility Company requirements.
8. State and Federal Safety and Health Laws.
9. National Electrical Safety Code (NESC).
10. Amendments to Codes.
11. Clean Water Act compliance for storm water and potable water discharges.
12. NSF International Standards 60 and 61.

C. Detailed Requirements: Be familiar with and verify detailed requirements of applicable codes to verify that items and their installation provided under Work of this Contract meet or exceed legal requirements.

1. Discrepancies: If discrepancies occur between the Contract Documents, local codes, local utility requirements, etc., most stringent requirements shall apply.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01612

SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment.
   2. Seismic design and anchorage of tanks and vessels, unless indicated otherwise in tank and vessel specifications.
   3. Other structures or items as specified or indicated on the Drawings.

1.02 REFERENCES

A. International Building Code, 2018.

B. American Society of Civil Engineers Standard 7 - Minimum Design Loads for Buildings and Other Structures.

1.03 SYSTEM DESCRIPTION

A. Design requirements: Design in accordance with the requirements of the International Building Code:
   1. International Building Code Site Classification of "C" may be utilized for design.
   2. Seismic Importance Factor For Anchorage Of Mechanical And Electrical Equipment: 1.25.
   3. Seismic Importance Factor For The Design Of Tanks And The Anchorage Of Tanks: 1.25.
   4. Do not use friction to resist sliding due to seismic forces.
   5. Use anchor bolts, bolts, studs for anchors for resisting seismic forces. Anchor bolts used to resist seismic forces shall have a standard hex bolt head. Do not use anchor bolts fabricated from rod stock with an L or J shape:
      a. Do not use concrete anchors, flush shells, chemical anchors, powder actuated fasteners, or other types of anchors unless indicated on the Drawings or accepted by the ENGINEER.
      b. Seismic forces must be resisted by direct bearing on the fasteners used to resist seismic forces. Do not use connections which use friction to resist seismic forces.

1.04 SUBMITTALS

A. Shop Drawings and Calculations: Provide seismic calculations and required details with the applicable equipment shop drawing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01650

DEMONSTRATION OF SYSTEMS/COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Pre-operational, Startup and Commissioning.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.

1.02 DEFINITIONS

A. Pre-operational Period: The period of time after the initial installation/construction.

B. Startup Period: A period of time (anticipated two weeks) immediately following the completion of the pre-operational period during which the CONTRACTOR initiates flow through the facility, starts up process equipment, calibrates and adjusts systems, completes OWNER training, and confirms the equipment is working as a system. During this period, the CONTRACTOR and his manufacturer's agents verify installation requirements.

C. Commissioning Period: A specific consecutive period of time (5 days) immediately following the completion of the startup period during which the ENGINEER operates the water treatment facility with support from the CONTRACTOR and OWNER.

D. Post Demonstration Period: The period of time after successful completion of the commissioning period but before final acceptance of Project during which the CONTRACTOR completes all punch list items and Project closeout procedures, and the OWNER has accepted ownership of the facility.

1.03 SUBMITTALS

A. General:
   1. Approved Operation and Maintenance manuals prior to start of startup.
   2. Written request for OWNER and ENGINEER to witness each system start-up. Request to be received by OWNER minimum two weeks before scheduled training of OWNER's personnel on that system.
   3. Equipment installation and start-up certifications.

4. Letter verifying completion of all pre-operational testing and start-up activities including receipt of all specified items from manufacturers/suppliers as final item prior to initiation of commissioning.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXECUTION

A. General:
1. Demonstration and commissioning of systems of the facilities constructed under this Contract shall be performed in two phases, as indicated in Article 1.02.

B. Pre-operational Period:
1. CONTRACTOR requirements:
a. Properly connect, align, calibrate, and adjust all system components. Check out procedures include but are not limited to:
1) Ring out all power, control and monitoring circuits prior to connection.
2) Voltage check of all circuits.
3) Phase sequence check.
4) Connecting piping system cleanliness check.
5) Alignment check of all connected machinery.
6) Pressure and vacuum testing of all closed systems.
7) Check of lubrication.
8) Calibration of all safety equipment.
9) Manual rotation/movement of moving parts to assure freedom of movement.
10) "Bump starting" of electrical motors to verify proper rotation.
11) Check of valving orientation and position status for manual operating mode.
12) Clean water testing of tankage for integrity.
13) Verify proper instrumentation and control signal generation, transmission, reception and response.
14) Check that all tagging/identification systems are in place.
15) Achieve successful bateriological test for piping and equipment.
b. OWNER shall witness CONTRACTOR operation of each system prior to training to verify functional integrity.
c. Provide all labor, supervision, utilities, equipment, vehicles, and required items necessary to perform work during this period.

d. Provide certificate signed by equipment manufacturer's representative and CONTRACTOR that equipment was correctly installed and is ready for operation (as shown in Exhibit A-1650).

C. Startup Period:

1. CONTRACTOR Requirements:
   a) CONTRACTOR shall provide temporary source of potable water from the existing fire hydrant to facilitate startup.
   b) Startup process equipment.
   c) Calibrate and adjust system.
   d) Provide training of OWNER personnel on all equipment during the startup period:
      1) OWNER personnel training on individual systems will not be considered as meeting the Contract requirements unless:
         (a) All pretraining deliverables are received and approved.
         (b) During training, all system malfunctions are addressed.
         (c) All provisions of field/classroom training specifications are met.
      2) Training not in compliance with the above will be performed again in its entirety by the manufacturer at no additional cost to OWNER.
      3) Training shall not be conducted until water is running through the well house, and the equipment is operational.
   e) Maintain the facilities.
2. ENGINEER Responsibilities:
   a) Prepare start-up plan for water treatment facility.
   b) Operate treatment facility to demonstrate compliance with water quality standards.
   c) Collect water quality samples.
3. OWNER Responsibilities:
   a) Provide well water.
   b) Provide chemicals and power.

D. Commissioning Period for Water Treatment Plant:

1. CONTRACTOR Responsibilities:
   a) Complete punch list items.
   b) Assist ENGINEER with manpower as needed to operate the facilities.
   c) Maintain the facilities.
   d) During this period, treated water will be discharged to OWNER's distribution system.
2. ENGINEER Requirements:
   a) Prepare commissioning plan.

b) Operate facilities to demonstrate compliance with water quality standards, and various operating modes.

3. OWNER Responsibilities:
   a) Collect, and perform lab water quality tests at their cost.
   b) Provide well water.
   c) Assist with operations and sampling.

END OF SECTION

CERTIFICATE OF EQUIPMENT INSTALLATION AND STARTUP SERVICES

Project: NTUA - MONTEZUMA CREEK ARSENIC TREATMENT FACILITIES

Equipment (Individual Component): _____

Specification Section: _____

Contract: _____

I hereby certify that the named equipment has been inspected by the Manufacturer's Representative and further certify:

1. That the equipment is properly installed and is in accordance with the Contract Documents.
2. That equipment is tested and is functioning as intended.
3. That nothing in the installation shall void the warranty.
4. That equipment, as installed, is ready to be operated by others.

MANUFACTURER'S REPRESENTATIVE

Signature: _____ Date: _____

Name (print): _____

Title: _____

Representing: _____

CONTRACTOR

Signature: _____ Date: _____

Name (print): _____

Title: _____

SECTION 01651

TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall make all arrangements for transportation, delivery and handling of equipment and materials required for prosecution and completion of the Work.

B. Shipments of materials to CONTRACTOR or subcontractors shall be delivered to the site only during regular working hours. Shipments shall be addressed and consigned to the proper party giving name of Project, street number and city. Shipments shall not be delivered to OWNER, except where otherwise directed.

C. If necessary to move stored materials and equipment during construction, CONTRACTOR shall move materials and equipment without any additional compensation.

1.02 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, OWNER'S contract name and number, CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Protect products from exposure to the elements and keep thoroughly dry and dust free at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.

D. Do not have products shipped until:
   1. Related Shop Drawings have been approved by ENGINEER.
   2. Related factory test results, required in the individual Specification Sections, have been reviewed and accepted by ENGINEER.
   3. Required storage facilities have been provided.

1.03 DELIVERY

A. CONTRACTOR shall arrange, with the United States Postal Service, a special address for the Project, if needed. All deliveries shall be made to that address.

B. Arrange deliveries of products in accordance with construction schedules and in ample time to facilitate inspection prior to installation.

C. Coordinate deliveries to avoid conflict with Work and conditions on site and to accommodate the following:
   1. Work of other contractors, or OWNER.
   2. Limitations of storage space.
   3. Availability of equipment and personnel for handling products.
   4. OWNER'S use of premises.

D. Have products delivered to site in manufacturer's original, unopened, labeled containers. Keep ENGINEER informed of delivery of all equipment to be incorporated in the Work.

E. Partial deliveries of component parts of equipment shall be clearly marked to identify the equipment, to permit easy accumulation of parts and to facilitate assembly.

F. Immediately on delivery, inspect shipment to assure:
   1. Product complies with requirements of Contract Documents and reviewed submittal.
   2. Quantities are correct.
   3. Containers and packages are intact, and labels are legible.
   4. Products are properly protected and undamaged.

G. Promptly remove damaged products from the Project site and expedite delivery of new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.04 PRODUCT HANDLING

A. Provide equipment and personnel necessary to handle products, including those provided by OWNER, by methods to prevent soiling or damage to products or packaging.

B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.

C. Handle products by methods to prevent bending or overstressing.

D. Lift heavy components only at designated lifting points.

E. Materials and equipment shall at all times be handled in a safe manner and as recommended by manufacturer or supplier so that no damage will occur to them. Do not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01715

EQUIPMENT OPERATION AND MAINTENANCE INSTRUCTIONS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. This section of the specification describes the project requirements for equipment manufacturer representatives' instruction of the OWNER's operation and maintenance personnel in the proper operation and maintenance of the equipment furnished under the Contract.

B. The CONTRACTOR shall require the equipment manufacturer or supplier to include the costs for the on-site operation and maintenance equipment instructions specified herein in their price quotations for the equipment to be furnished under the Contract.

C. It is the goal and intent of the equipment operation and maintenance instruction specified herein to provide the OWNER's operation and maintenance personnel with technically accurate and current information on the theory, design, practical operation and maintenance, appropriate hands-on or field experience such that the equipment, systems and/or components can be efficiently operated and maintained by the OWNER's staff upon completion of the instruction program.

1.02 OPERATION AND MAINTENANCE INSTRUCTIONS

A. An experienced and authorized representative of the manufacturer or supplier of each item of equipment listed below shall conduct an instruction program on the proper operation and maintenance of the equipment. Instruction shall be given only by qualified persons who are familiar with the equipment and systems installed in the work. The required amount of continuous on-site instruction for each item of equipment is specified in Divisions 11, 13, 15, and 16.

B. Equipment manufacturer operation and maintenance manuals, conforming to the requirements of Section 01340 of these specifications shall be available for use in training.

C. The CONTRACTOR shall be solely responsible for scheduling the respective equipment operation and maintenance instruction sessions with the ENGINEER and OWNER. The instruction sessions shall be conducted with the installed equipment being fully tested, adjusted and operational. The equipment operation and maintenance instruction may be scheduled to immediately follow the manufacturer or suppliers representative's field inspection and final adjustment of the equipment provided that the representative can certify that the equipment has been installed in accordance with manufacturer's instructions and procedures and the equipment and controls operate properly.

D. The equipment operation and maintenance instruction sessions shall, as a minimum, cover the material presented in the manufacturer's O&M user manuals which shall serve as the manual for the instruction program, and the instruction sessions shall consist of both classroom instruction and field hands-on instruction. The instruction sessions for equipment or systems shall include separate material presentations for the mechanical, electrical, and instrumentation portions of the equipment or system. The manufacturer's representative who will be conducting the training program shall prepare an outline of the material to be covered during both the classroom and hands-on field portions of instruction. The outline shall briefly describe what is to be discussed under each item, audio visual aids and other materials to be used in support of the O&M user manual material. The CONTRACTOR shall submit the training program outline to the ENGINEER at least thirty (30) days in advance of the start of the program to allow the ENGINEER adequate time to review its contents. The format and contents of the respective equipment instruction programs shall be changed to incorporate the OWNER's and ENGINEER's review comments on the program outline.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 OPERATION TRAINING - THE OPERATION TRAINING SESSIONS SHALL INCLUDE, BUT NOT BE LIMITED TO, THE FOLLOWING

A. Overview of the equipment and auxiliary or support systems covering nomenclature, function and theory of operation.

B. General safety requirements for operation of the equipment and auxiliary or support systems, including suggested safety equipment.

C. Pre-startup safety and equipment check.

D. Equipment and auxiliary or support systems startup procedures covering manual and automatic modes, if applicable.

E. Equipment or system operation and monitoring requirements; including specifics on normally expected ranges for items such as oil, water pressure and temperature, discharge pressures, sensory observations, and procedures to change operation parameters (such as air or flow rate).

F. Equipment and systems shut down procedures covering manual and automatic and modes (if available).

G. Operational troubleshooting of equipment and auxiliary or support systems.

H. Procedure for handling non-routine operational problems such as response to alarms, power failures, emergency shutdown, and auxiliary or support system failures.

3.02 MAINTENANCE TRAINING - THE MAINTENANCE TRAINING SESSIONS SHALL BE COORDINATED AS EXPLAINED HERE UNDER

A. If a session is specific to a discipline (electrical, mechanical, electrical/ instrumentation) include only appropriate maintenance items for that discipline; if sessions are to include multiple disciplines, include all items for all disciplines and indicate in submittal outline which discipline the material refers to.

B. All disciplines shall include, but not be limited to, the following:
   1. Overview of the equipment and auxiliary or support systems covering nomenclature, function and theory of operation.
   2. General safety requirements for maintenance of the equipment and auxiliary support systems appropriate to each discipline including suggested equipment and practices. Cover local and remote lockout procedures, safe procedure for handling alarms and built-in safety devices during preventive and corrective maintenance.
   3. Overview of pre-startup, routine operation monitoring, and shutdown procedures covering automatic and manual modes (if applicable).

C. Each specific discipline shall include, but not be limited to, the following:
   1. Provide preventive maintenance procedures to be followed; include parts, lubrication quantities, types, frequencies, application points, and time requirements to perform procedures.
   2. Specific procedures to cover adjustments required for alignment, wear, calibration for all preventive maintenance and corrective maintenance procedures including time required to perform.
   3. Special tools, techniques or procedures required for either preventive or corrective maintenance of equipment or its' auxiliary or support systems.
   4. Assembly and disassembly procedures required for preventive or corrective maintenance (the use of models, "exploded" views, part listed, hands-on field training or other audio visual materials are recommended for this area of training). Include time requirements for procedures performed.
   5. Maintenance troubleshooting of equipment and auxiliary systems.

3.03 CERTIFICATES OF TRAINING

A. Provide Certificate signed by equipment manufacturer, CONTRACTOR and OWNER documenting that training was successfully completed.

END OF SECTION

CERTIFICATE OF TRAINING

Project: NTUA – Montezuma Creek Arsenic Treatment Facilities

Equipment (Individual Component): _____

Specification Section: _____

Contractor: _____

The training has been successfully provided by the manufacturer's representative to the City.

MANUFACTURER'S REPRESENTATIVE

Signature: _____ Date: _____

Name (print): _____

Title: _____

Representing: _____

CONTRACTOR

Signature: _____ Date: _____

Name (print): _____

Title: _____

NTUA

Signature: _____ Date: _____

Name (print): _____

Title: _____

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Contract closeout requirements including:
   1. Final cleaning.
   2. Disinfection of systems.
   3. Preparation and submittal of closeout documents.
   4. Final completion certification.

1.02 FINAL CLEANING

A. Perform final cleaning prior to inspections for acceptance of the Work:
   1. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.
   2. Remove non-permanent protection and labels.
   3. Clean light fixtures and replace burned-out or dim lamps.

1.03 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site.

B. Do not create unsightly or unsanitary nuisances during disposal operations.

1.04 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for acceptance of the Work.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.05 CLOSEOUT DOCUMENTS

A. Submit following Closeout Submittals upon completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Evidence of compliance with requirements of governing authorities.
   2. Project Record Documents - Record Drawings shall be prepared for all the Work included in the Contract and shall include the actual in-place installation of the items installed under this Contract.

3. Operation and Maintenance Manuals.
4. Warranties and Bonds.
5. Evidence of Payment and Release of Liens as outlined in Conditions of the Contract.
6. Release of claims as outlined in Conditions of the Contract.
7. Red-Line as-builts.

1.06 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

A. Submit the following:
1. Certificate of Inspection as required.
2. Certificate of Occupancy will not be required.

1.07 WARRANTIES AND BONDS

A. Provide executed Warranty or Guaranty Form if required by Contract Documents.

B. Provide specified additional warranties, guarantees, and bonds from manufacturers and suppliers.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

DIVISION 2

SITEWORK

SECTION 02072

DEMOLITION, CUTTING AND PATCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. All demolition, cutting and patching.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.

1.02 QUALITY ASSURANCE

A. Use only firms or individual trades qualified to perform work required under this Section.

1.03 SUBMITTALS

A. Not Used.

1.04 DELIVERY, STORAGE, AND HANDLING

A. General:
   1. Salvage items, designated for OWNER's salvage, as a unit. Clean, list, and tag for storage. Protect from damage and store on-site where designated by OWNER. Salvage each item with auxiliary or associated equipment required for operation.

1.05 PROJECT/SITE CONDITIONS

A. Perform preliminary investigations as required to ascertain extent of work. Conditions which would be apparent by such investigation will not be allowed as cause for claims for extra costs.

1.06 SEQUENCING AND SCHEDULING

A. Coordinate and reschedule work as required to preclude interference with other operations.

1.07 PERMITS

A. Obtain and pay for all permits required by all authorities having jurisdiction and notify all involved utility companies.

B. Obtain approval of authorities having jurisdiction for any work which affects access to or exit from such areas. Obtain approval of authorities for any temporary construction which affects such areas.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Nonshrink grout:
      a. Masterflow 713 by Master Builders.
      b. Or pre-approved equal.
   2. Epoxy bonding adhesive:
      a. Euco No. 452 MV by Euclid Chemical Co.
      b. Sikadur 32 Hi-Mod by Sika Corporation.
      c. Or pre-approved equal.

2.02 MATERIALS

A. Nonshrink Grout:
   1. Non-metallic, non-corrosive and non-staining.
   2. Premixed with only water to be added in accordance with manufacturer's instructions at the job site.
   3. Grout to produce a positive but controlled expansion. Mass expansion not to be created by gas liberation or by other means.
   4. Minimum compressive strength at 28 days to be 6500 psi.
   5. Coat exposed edges of grout with a cure/seal compound recommended by grout manufacturer.

B. Epoxy Bonding Adhesive:
   1. Two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.

PART 3 EXECUTION

3.01 PREPARATION

A. Provide substantial barricades and safety lights as required.

B. Provide temporary weather protection as necessary.

3.02 INSTALLATION

A. Cutting and Removal:
   1. Remove existing work indicated to be removed, or as necessary for installation of new work.
   2. Neatly cut and remove materials, and prepare all openings to receive new work.
   3. Remove masonry or concrete in small sections.

B. Modification of Existing Concrete:
   1. Where indicated, remove existing concrete and finish remaining surfaces as specified in Section 03300:
      a. Protect remaining concrete from damage.
      b. Make openings by sawing through the existing concrete.
      c. Concrete may be broken out after initial saw cuts in the event concrete thickness prevents cutting through.
      d. Where sawing is not possible, make openings by drilling holes around perimeter of opening and then chipping out the concrete:
         1) Holes shall be sufficient in number to prevent damage to remaining concrete.
   2. Oversize required openings in existing concrete 1 IN on all sides and build back to required opening size by means of nonshrink grout epoxy bonded to the existing concrete.
   3. Where oversized openings cannot be made, remove the concrete to the required opening size and cut back exposed reinforcing 1 IN from face of concrete and fill resulting holes with nonshrink grout.

C. Matching and Patching:
   1. Methods and materials:
      a. Similar in appearance, and equal in quality to adjacent areas for areas or surfaces being repaired.
      b. Subject to review of ENGINEER.

D. Salvaged Items:
   1. Thoroughly dry and clean all metal surfaces.
   2. Prime all bare metal in accordance with Section 09800.

3. Dispose of items or materials not designated for OWNER's salvage or reuse. Promptly remove from site.
4. Do not store or sell CONTRACTOR salvaged items or materials on site.

E. Clean up:
1. Transport debris and legally dispose of off site.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to structures.
   2. Backfilling and compacting around structures.

B. See Drawings.

1.02 REFERENCES

A. Associated General Contractors (AGC):
   1. Manual of Accident Prevention in Construction (Section 9).

B. American Society for Testing and Materials (ASTM):
   1. C 33 - Standard Specification for Concrete Aggregates.
   2. C 117 - Standard Method for Materials Finer Than 75-µm (No. 200) in Mineral Aggregate by Washing.
   3. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   4. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   5. D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
   6. D 1241 - Standard Specification for Materials for Soil Aggregate Subbase, Base and Surface Courses.
   7. D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   8. D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
   9. D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   10. D 4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   11. D 4254 - Stand Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   12. D 4318 - Standard Test Method for Liquid Limit, Plastic Limit and Plasticity

Index of Soils.

13. D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

C. Institute of Makers of Explosives (IOMOE).

D. Occupational Safety and Health Act (OSHA).

E. American Association of State Highway & Transportation Officials (AASHTO).

1.03 DEFINITIONS

A. Excavation: Consists of satisfactory loosening, removing, loading, transporting, depositing, and compacting in final location materials, wet and dry, necessary to be removed for purposes of construction, or as required for ditches, grading, roads, structures, and such other purposes as are indicated on the Drawings.

B. Backfill Adjacent to Structures: Backfill within volume delimited by exterior surfaces of structures, surface of undisturbed soil in excavation around structures, and finish grade around structure.

C. In-Place Density of Compacted Backfill: Density determined in accordance with ASTM D 698, and with ASTM D 6938.

D. Maximum Density: Is density obtained in laboratory when tested in accordance with ASTM D 698.

E. Definitions Related to Compaction of Coarse Fill:

1. One Pass: Defined as one movement of roller over area being compacted.
2. Measurement Of Pass Width: Measure width of pass between centers of outside tires or outside edge of roller wheel.

1.04 SYSTEM DESCRIPTION

A. Clearing, grubbing, and site preparation.

B. Removal and disposal of debris.

C. Handling, storage, transportation and disposal of excavated material.

D. Sheeting, shoring, bracing and protection work.

E. Pumping and dewatering as required or necessary.

F. Backfilling.

G. Pipe embedment.

H. Trench stabilization.

I. Final grading

J. Appurtenant Work

1.05 SUBMITTALS

A. Submit under the provisions of Section 01340.

B. Test Reports: Indicate supplier, sieve analysis, and maximum relative density in accordance with ASTM D 4253 and D4254 for crushed rock or grave, pipe embedment, etc.

C. Product Data: Submit material source, gradation, moisture density curve, and testing data for all imported materials.

1.06 REGULATORY REQUIREMENTS

A. Comply with all requirements of Stormwater Pollution Prevention Plan.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Protect adjacent structures and surrounding areas from damage during excavation, filling, and backfilling.

B. Protect work from erosion or other similar types of damage until the project has been completed.

C. Do not backfill or construct fills during freezing weather. Backfill or construct fills only when temperature is 35 degrees F and rising.

D. Do not use frozen materials, snow or ice in any backfill or fill area.

E. Do not backfill or construct fill on frozen surfaces.

F. Protect excavated material from becoming frozen.

G. Do not remove trees from outside excavation or fill areas unless authorized by the ENGINEER; protect from permanent damage by construction activities.

H. Provide temporary bridges for roadways, walkways, driveways, etc.

1.07 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements as provided in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it in specified locations.

C. Excavation and Filling: Perform excavation and filling, during construction, in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water For Compacting Fills: Use water from source acceptable to OWNER.

B. Classification of Excavated Materials:
   1. Remove and handle excavated materials regardless of type, character, composition, condition, or depth of material at no additional cost to the OWNER.
   2. Excavations greater than 4.0 feet should be sloped and braced.

C. Fill and Backfill Materials:
   1. General:
      a. For over-excavation of the site expansion from existing ground surface down to elevation as shown on the Drawings, provide crushed rock and native material, where required for fill and backfill.
      d. Obtain material for fills from cut sections or from borrow source.
      e. Materials derived from processing demolished or removed asphalt concrete are not acceptable.
   2. Gravel:
      a. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to specified sizes and gradations.
      b. Free from frozen material vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
      c. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
         1) Durability Index: Percentage of wear not greater than 40 percent after 500 revolutions when tested in accordance with ASTM C 131.
         2) Plasticity Index: Not greater than 5 when tested in accordance with ASTM D 4318.
         3) Liquid Limit: Not greater than 25 percent when tested in

accordance with ASTM D 4318.

d. Conform to sizes and grade within the limits as follows when tested in accordance with ASTM C136 and ASTM C 117.

Sieve Size (Square Openings)	Percent By Weight	
	Type A	Type B
3 inch	100	–
1-1/2 inch	–	100
Number 4	30 - 75	30 - 70
Number 8	20 - 60	20 - 60
Number 30	10 - 40	10 - 40
Number 200	0 - 12	0 - 12

3. Native Material:
   a. Clean onsite native soil with a maximum dimension of 4 inches, and passing 1 inch sieve.
   b. Percent of material by weight passing Number 200 sieve shall not exceed 30 when tested in accordance with ASTM C 136.
4. Top Soil:
   a. Native material removed and stockpiled before excavation
   b. Free from trash, debris, surface vegetation more than 6-inch high.

PART 3 EXECUTION

3.01 EXAMINATION

A. Field verify the location of all underground utilities, pipelines and structures prior to excavation.

3.02 PREPARATION

A. Clear sites to be occupied by permanent construction of roots, brush, and other objectionable materia and debris.

3.03 CRUSHED ROCK OR GRAVEL FILLS

A. Place on suitably prepared subgrade and compacted.

B. Compacted by vibration.

3.04 PROTECTION

A. Finish Grades of Excavations, Backfilling and Fill:
   1. Protect newly graded areas from action of the elements.

3.05 DISPOSAL OF EXCAVATED MATERIAL

A. Unusable material or excavated material in excess of that needed for backfill or fill offsite shall become the property of the CONTRACTOR and shall be removed from the project site and legally disposed of at no cost to the OWNER.

END OF SECTION

SECTION 02445

CHAIN LINK FENCE AND GATE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies chain link fence comprising fencing, gate, and appurtenances.

B. See Drawings.

1.02 FACTORY TESTING

A. Wire fabric and barbed wire shall be tested for zinc coating weight by the method specified in ASTM A90. Ferrous metal, except the fabric, shall be tested for zinc coating uniformity by the method specified in ASTM A239; zinc coating shall withstand six 1-minute dips.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. A90/A90M - Standard Test Method for Weight of Coating on Iron & Steel Articles with Zinc or Zinc Alloy Coatings.
2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.
3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. A153/A153M - Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
5. A239 - Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.
6. ASTM A392 - Specification for Zinc-Coated Steel Chain Link Fence Fabric.
7. F567-Standard Practice for Installation of Chain Link Fence.
8. ASTM F900 - Standard Specifications for Industrial and Commercial Swing Gates.

1.04 SUBMITTAL

A. Manufacturer's product information designating specific materials provided.

B. The layout of the chain link fence as it is to be provided illustrating fence height, post sizes, bracing configurations, and accessories.

C. Fence Appurtenances.

D. Knox Box.

PART 2 PRODUCTS

2.01 MATERIALS

A. Chain Link Fabric:
   1. Fabric to have 75,000 psi tensile strength. Chain link fabric shall be 2-inch mesh 9-gauge core wire. Height of fabric shall be 6 feet 0 inch (plus or minus 3/4 inch).
   2. Fabric shall conform with the requirements of ASTM A392,and shall have a class 2 zinc coating, hot dip galvanized after fabrication.

B. Bottom Tension Wire:
   1. Bottom tension wire shall be at least 7-gage galvanized coil spring steel.

C. Posts, Top Rail, and Braces:
   1. Pipe used shall be ASTM A53, Schedule 40 steel pipe. Posts, rails, braces and frames shall be hot-dip galvanized per ASTM A53, A123 or A153, whichever is applicable. Galvanizing shall be applied at least 2.0 ounces of zinc per square foot of surface.
   2. Line posts shall be 2-3/8-inch outside diameter pipe weighing 3.65 pounds per foot. Corner and end posts shall be minimum 2-7/8-inch outside diameter pipe weighing a minimum of 5.79 pounds per foot. Braces shall be 1 5/8-inch outside diameter pipe weighing 2.27 pounds per foot.
   3. Top rails shall be 1.90-inch outside diameter weighing 2.72 pounds per foot.
   4. Provide galvanized rampart with three lines of galvanized barbed wire.

D. Truss Rods and Miscellaneous Fittings:
   1. Truss rods shall be fabricated of 3/8-inch diameter steel rods and shall have turnbuckles or similar means of adjustment. Fittings used shall be hot-dip galvanized iron or steel with a minimum coating of at least 2.0 ounces of zinc per square foot of surface in accordance with ASTM A123 or A153, whichever is applicable.

E. Concrete:
   1. Concrete for post foundations shall be Class C as specified in Section 03300.

F. Gates:
   1. Provide double swing gate as shown on the Drawings. Gate shall be manufactured of galvanized materials. Provide center post and hasp for a padlock. Gate shall be provided with x-bracing to prevent sagging.
   2. Double Swing Gates shall comply with ASTM F900.

G. Knox Box:

1. Provide Knox Box 3200 series with hinged door. Unit shall be dark bronze color and surface mount. Confirm type of Knox Box with Navajo Nation Fire and Rescue before ordering.

PART 3 EXECUTION

3.01 FENCE

A. Line posts shall be equally spaced between corners and posts at a spacing not exceeding 10 feet. The base top shall be at least 1 inch above grade and sloped for drainage. Posts shall be set vertical, shall be accurately aligned, and shall have their tops level or at a constant slope between changes in grade. Tubular posts shall be fitted with extension arms for barbed wire, post top to permit passage of top rail or rainproof malleable iron caps as applicable.

B. Corner and end posts shall be braced to the nearest line post. Corner and end posts shall be diagonally braced. Line posts shall be braced horizontally and trussed in both directions with truss rods at 1000-foot minimum intervals. Top rails, where specified, shall be in lengths not less than 18 feet and shall be fitted with couplings for connecting lengths into continuous runs. Couplings shall be not less than 6 inches long and allow for expansion and contraction of the rail.

C. Chain link fabric shall be taut and shall be attached to posts, rails, and wires with galvanized fabric bands or tie wires at a maximum spacing of 12 inches on posts and 18 inches on the rails and tension wires. Stretcher bars shall be provided at ends of fabric. The bottom tension wire shall be stretched tight and shall be located 2 inches maximum above finished grade and on a straight grade between posts by excavating the high points of ground, and in no case shall depressions be filled.

D. Provide top rail. In addition, provide 1 ft. high barbed wire extension on top of 6 ft high chain link fence.

E. CONTRACTOR shall provide additional fence posts as necessary to install gates.

F. Install chain link fence in accordance with ASTM F567.

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03100

CONCRETE WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Concrete formwork.

B. Related Sections: Section 3600 - Grout.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Specification for Tolerances for Concrete Construction and Materials and Commentary.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Design concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
   2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance Requirements:
   1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
   3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
   4. Use forms that are clean and free from dirt, debris, concrete, and similar type items. Coat with acceptable form release oil if required, prior to use or reuse.

1.04 QUALITY ASSURANCE

A. Qualifications of Formwork Manufacturers: Use only forming systems manufactured by manufacturers having minimum 5 years experience, except as otherwise specified.

B. Regulatory Requirements: Install work of this Section in accordance with local, state, and federal regulations.

1.05 PROJECT CONDITIONS

A. Requirements Due to Weather Conditions:
1. Removal of Formwork: Do not remove forms from concrete which has been placed when outside ambient air temperature is below 50 degrees Fahrenheit until concrete has attained specified strength as determined by test cylinders stored in field under equivalent conditions as concrete structure.

PART 2 PRODUCTS

2.01 MATERIALS

A. Form Ties:
1. General:
a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
b. Do not use wire ties or wood spreaders of any form.
c. Provide ties of type that accurately tie, lock, and spread forms.
d. Provide form ties of such design that when forms are removed they locate no metal or other material within 1-½ inches of the surface of the concrete.
e. Do not allow holes in forms for ties to allow leakage during placement of concrete.
2. Cone-Snap or Flat Bar Form Ties:
a. Cone-snap ties shall form a cone shaped depression in the concrete with a minimum diameter of 1 inch at the surface of the concrete and 1-½ inches deep.
b. Provide neoprene waterseal washer which is located near the center of the concrete.
3. Taper Ties:
a. Neoprene Plugs for Taper Tie Holes: Size so that after they are driven, plugs are located in center third of wall thickness.
b. Drypack Mortar for Filling Taper Tie Holes:
1) Consist of mix of one part of Portland Cement to one part of plaster sand.
2) Amount of water to be added to cement-sand mix is to be such that mortar can be driven into holes and be properly compacted.
3) Admixtures or additives: Are not to be used in drypack mortar.

B. Built-Up Plywood Forms:
1. Built-up plywood forms may be substituted for prefabricated forming system following minimum requirements:
a. Size and Material:
1) Full size 4 by 8 feet plywood sheets, except where smaller pieces are able to cover entire area.

2) Sheet Construction: 5-ply plywood sheets, ¾ inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

b. Wales: Minimum 2 by 4 inch lumber.

c. Studding And Wales: Contain no loose knots and be free of warps, cups, and bows.

C. Steel or Steel Framed Forms:

1. Steel Forms: Provide forms that are:
   a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
   b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
2. Steel Framed Plywood Forms:
   a. Provide forms that are rigidly constructed and capable of being braced.
   b. Plywood Paneling: 5-ply, 5/8 inch nominal or ¾ inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

D. Incidentals:

1. External Angles:
   a. Where not otherwise indicated on the Drawings, provide with ¾ inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
   b. Provide ¼ inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, contraction, and construction joints.
2. Keyways: Steel, plastic, or lumber treated with form coating, applied according to label directions.
3. Inserts: Dovetail Anchors or Ties.
4. Pipe Sleeves: Refer to Drawings for type, location, and sizes. All sleeves shall be made of cast iron, unless noted otherwise.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
1. Do not place any concrete until all forms have been thoroughly checked for alignment, level, strength, and to assure accurate location of all mechanical and electrical inserts or other embedded items.

3.02 INSTALLATION

A. Forms and Accessories:
1. Vertical Forms:
a. Remain in place minimum of 24 hours after concrete is placed.
b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.
2. Other Forms Supporting Concrete And Shoring: Remain in place as follows:
a. Sides of Footings: 24 hours minimum.
b. Vertical Sides of Beams, Girders, And Similar Members: 48 hours minimum.
c. Slabs, Beams, and Girders: Until concrete strength reaches specified strength or until shoring is installed.
d. Shoring for Slabs, Beams, and Girders: Shore until concrete strength reaches specified strength.
e. Wall Bracing: Until concrete strength of beams and slabs laterally supporting wall reaches specified strength.

B. Form Ties:
1. Cone-Snap Rod and Bar Ties: Tie forms together at not more than 2 foot centers vertically and horizontally. After forms are removed from wall, fill tie holes as follows:
a. Remove form ties from surfaces.
b. Roughen cone shaped tie holes by heavy sandblasting before repair.
c. Dry pack cone shaped tie holes with drypack mortar as specified in Section 03600.
2. Taper Ties:
a. Neoprene Plug in Taper Tie Holes: After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
1) Heavy sandblast and then clean tie holes.
2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
3) Locate steel rod in cylindrical recess, made in plug, during driving:

a) At no time are plugs to be driven on flat area outside cylindrical recess.

b. Dry Pack of Taper Tie Holes: After installing plugs in tie holes:

1) Coat tie hole surface with epoxy bonding agent and fill with drypack mortar as specified in Section 03600.

a) Drypack Mortar: Place in holes in layers with thickness no exceeding tie hole diameter and heavily compact each layer.

b) Drypack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.

c) Wall surfaces in area of drypacked tie holes: On the water side of water containing structures and the outside of below grade walls:

(1) Cover with minimum of 10 mils of epoxy gel.

(2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past drypack mortar filled tie holes.

(3) Provide finish surfaces that are free from sand streaks or other voids.

3. For water retaining structures, use taper ties. No other type of tie will be allowed.

C. Built-Up Plywood Forms:

1. Studding:

a. Spaced at 16 inches or 24 inches on center.

b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.

c. Install studs perpendicular to grain of exterior plys of plywood sheets.

2. Wales: Form wales of double lumber material minimum size as specified in this Section.

3. Number of Form Reuses: Depends upon durability of surface coating of overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

D. Steel or Steel Framed Forms:

1. Steel Forms:

a. Adequately brace forms for minimum deflection of finish surface.

2. Steel Framed Plywood Forms:

a. Rigidly construct and brace with joints fitting closely and smoothly.

b. Number of Form Reuses: Depends upon durability of surface coating or overlay used.

3. Built-Up Plywood Forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

E. Bracing and Alignment of Forms:
   1. Line and Grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
   2. Formwork:
      a. Securely brace, support, tie down, or otherwise hold in place to prevent any movement.
      b. Make adequate provisions for uplift pressure, lateral pressure on forms, and defection of forms.
   3. When Second Lift is Placed on Hardened Concrete: Take special precautions in formwork at top of old lift and bottom of new lift to prevent:
      a. Spreading and vertical or horizontal displacement of forms.
      b. Grout "bleeding" on finish concrete surfaces.
   4. Pipe Stubs, Anchor Bolts, and Other Embedded Items: Set in forms where required.
   5. Cracks, Openings, or Offsets At Joints in Formwork: Close those that are 1/16 inch or larger by tightening forms of by filling with acceptable crack filler.

F. Incidentals:
   1. Keyways: Construct keyways as indicated on the Drawings.
   2. Reentrant Angles: May be left square.
   3. Level Strips: Install level strips at top of wall concrete placements to maintain true line at horizontal construction joints.
   4. Inserts:
      a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.
      b. Use dovetail anchors or ties in conjunction with slots or inserts for various materials as specified under other sections of these Specifications and as may be necessary for required work.

G. Pipe and Conduit:
   1. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 07900, unless otherwise specified.

H. Tolerances:
   1. Finish concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. The maximum deviation from true line and grade shall not exceed tolerances listed below at time of acceptance of project.
   3. General: Comply with ACI 117, paragraphs 2.0 through 2.2 and paragraphs 4.0 through 4.5, except as modified in following:
      a. Slabs:
         1) Slope: Uniformly sloped to drain when slope is indicated on the Drawings.

2) Slabs Indicated to be Level: Have maximum deviation of 1/8 inch in 10 feet without any apparent changes in grade.

b. Inserts: Set inserts to tolerances require for proper installation and operation of equipment or systems to which insert pertains.

c. Maximum Tolerances: As follows:

Item	Inches
Sleeves and Inserts	Plus 1/8 Minus 1/8
Projected Ends of Anchor Bolts	Plus 1/4 Minus 0.0
Anchor Bolt Setting	Plus 1/16 Minus 1/16

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Concrete reinforcement.

B. Related Sections:
   1. Section 03100 - Concrete Formwork.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. SP-66 - ACI Detailing Manual.
   2. 315 - Details and Detailing of Concrete Reinforcement.
   3. 318 - Building Code Requirements for Structural Concrete and Commentary.

B. American Society for Testing and Materials (ASTM):
   1. A 143 - Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   2. A 185 - Standard Specification for Steel Welded Wire Reinforcement, Plain for Concrete.
   3. A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   4. A 767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   5. E 8 - Standard Test Methods for Tension Testing of Metallic Materials.
   6. A 706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

C. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

1.03 SYSTEM DESCRIPTION

A. The Drawings contain general notes concerning amount of reinforcement and placing, details for reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Shop Drawings on Reinforcing Steel:
      a. Submit to the ENGINEER reinforcing steel detail drawings in accordance with Contract Documents.
      b. Changes to Reinforcing Steel Contract Drawing Requirements:
         1) Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the drawings for reinforcing steel.
         2) Such changes will not be acceptable unless the ENGINEER has accepted such changes in writing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing And Shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance At Site:
   1. Reinforcing Bars: Deliver reinforcing bars accompanied by manufacturer's guarantee of grade.

C. Storage:
   1. All rebar shall be stored on dunnage.

1.06 SEQUENCING AND SCHEDULING

A. Bar Supports: Do not place concrete until samples and attached data of bar supports has been accepted by the ENGINEER.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcement:
   1. General: Provide reinforcing steel that is new material, of quality specified, free from excessive rust or scale or any defects affecting its usefulness.

B. Reinforcing Bars:
   1. Reinforcing Bars to be Embedded in Concrete or Masonry: Grade 60 deformed bars conforming to ASTM A 615 except as specified in the next subparagraph.
   2. Reinforcement resisting earthquake-induced flexural and axial forces in concrete frame members and in concrete wall boundary members shall comply with low alloy ASTM A 706. ASTM A 615 Grade 60 reinforcement may be used in these members if the following requirements are met:

a. The actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 pounds per square inch (retest shall not exceed this value by more than an additional 3,000 pounds per square inch).
b. The ratio of the actual ultimate tensile stress to the actual tensile yield strength is not less than 1.25.

3. Hot-Dip Galvanized Reinforcing Bars:
   a. When reinforcing bars are indicated on the Drawings to be hot-dip galvanized, perform such galvanizing in accordance with ASTM A 767 and ATM A 143.
   b. Galvanizing: Galvanize bars in conformance with Class 1 coating and perform galvanizing after fabrication and shearing.
4. Thread Bars:
   a. Provide thread bars having continuous rolled-in patter of thread-like deformations along entire length.
   b. Provide hex nuts and couplers for the thread bars that develop 125 percent of yield strength of bar.
   c. Thread Bars:
      1) Conform to ASTM A 615 Grade 60.
   d. Do not substitute cut threads on regular reinforcing bars for thread bars.

C. Bar Supports:
1. Reinforcement Support Chairs:
   a. Hot-dip galvanized steel. Provide hot-dip galvanized steel with plastic tips at surfaces which will be exposed to view. Use unless otherwise indicated on the Drawings.
   b. Stainless Steel where indicated on the Drawings.
   c. Provide concrete adobe blocks to support rebar associated with building foundation slabs.
   d. Other suitable material approved by ENGINEER.

D. Tie Wires: Annealed Steel.

2.02 FABRICATION

A. Shop Assembly:
1. Cut and bend bars in accordance with provisions of ACI 315 and ACI 318.
2. Bend bars cold.
3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Reinforcing Bars:
      a. Verify that bars are new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.

3.02 PREPARATION

A. Surface Preparation:
   1. Reinforcing Bars: Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars having rust scale, lose mill scale, or thick rust coat.
   2. Cleaning of Reinforcement Materials: Remove concrete of other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.03 INSTALLATION

A. Reinforcing Bars:
   1. No field bending of bars will be allowed on bars larger than #4.
   2. Welding:
      a. Weld reinforcing bars where indicted on the Drawings or acceptable to the ENGINEER.
      b. Perform welding in accordance with AWS D1.4.

B. Placing Reinforcing Bars:
   1. Accurately place bars and adequately secure them in position.
   2. Overlap bars at splices as specified or indicated on the Drawings.
   3. Unless specifically otherwise indicated on the Drawings, install bars at lap splices in contact with each other and fasten bars together with tie wire.
   4. If lap splice length for bars in concrete is not specified or indicated on the Drawings, bars shall be lap spliced in accordance with ACI 318.
   5. Bar Supports:
      a. Provide in sufficient number to prevent sagging and to support loads during construction, but in no case less than quantities and at locations as indicated in ACI 315.
      b. Support reinforcing for concrete places on ground by standard manufactured chairs, with steel plates for resting on ground.
      c. Do not use brick, broken concrete masonry units, spalls, rocks, or similar material for supporting reinforcing steel.
   6. If not indicated on the Drawings, provide protective concrete cover in accordance with ACI 318.

C. Tying of Bar Reinforcement:
   1. Fasten bars securely in place with wire ties.
   2. Tie bars sufficiently often to prevent shifting.
   3. There shall be at least 3 ties in each bar length (does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
   4. Tie slab bars at every intersection around periphery of slab.
   5. Tie wall bar and slab bar intersections other than around periphery at not less than every fourth intersection, but at not greater than following maximum spacing:

Bar Size	Slab Bars Spacing (Inches)	Wall Bars Spacing (Inches)
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

   6. After tying wire ties, bend ends of wire ties in towards the center of the concrete section. Wire ties shall conform to the cover requirements of the reinforcing bars.

D. Lap Splices of Reinforcing Bars:
   1. Where bars are to be lapped spliced at joints in concrete, ensure bars project from concrete first placed, minimum length equal to lap splice length indicated on the Drawings.
   2. Where lap splice length is not indicated on the Drawings, then provide lap splice length as specified in ACI 318 and this Division.

E. Welded Wire Fabric Reinforcement:
   1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
   2. Bend fabric as indicated on the Drawings or required to fit work.
   3. Unroll or otherwise straighten fabric to make perfectly flat sheet before placing in the Work.
   4. Lap splice welded wire fabric as indicated on the Drawings.
   5. If lap splice length is not shown on the Drawings, splice fabric in accordance with ACI 318.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Cast-in-place concrete.

B. Related Sections:
1. Section 03100 - Concrete Formwork.
2. Section 03200 - Concrete Reinforcement.
3. Section 03600 - Grout.

1.02 REFERENCES

A. American Concrete Institute (ACI):
1. 318 - Building Code Requirements for Structural Concrete and Commentary.
2. Manuals of Concrete Practice.
3. Recommended Practices.

B. American Society for Testing and Materials (ASTM):
1. C 31 - Standard Test Practice for Making and Curing Concrete Test Specimens in the Field.
2. C 33 - Standard Specification for Concrete Aggregates.
3. C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
5. C 42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
6. C 88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
7. C 94 - Standard Specification for Ready-Mixed Concrete.
8. C 114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
9. C 117 - Standard Test Method for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
10. C 123 - Standard Test Method for Lightweight Particles in Aggregate.
11. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
12. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
13. C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.

14. C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
15. C 150 - Standard Specification for Portland Cement.
16. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
17. C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
18. C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
19. C 203 - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
20. C 227 - Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
21. C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
22. C 1260 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Mortar Bar Method).
23. C 295 - Standard Guide for Petrographic Examination of Aggregates for Concrete.
24. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. C 311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
26. C 469 - Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
27. C 494 - Standard Specification for Chemical Admixtures for Concrete.
28. C 595 - Standard Specification for Blended Hydraulic Cements.
29. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
30. D 75 - Standard Practices for Sampling Aggregates.

1.03 DEFINITIONS

A. Alkali: Is defined to mean sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Hairline Crack: Crack with a crack width of less than 4 thousandths of an inch.

1.04 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in manner such as to secure lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within specified slump range.

c. Proportion fine and coarse aggregate in manner such as not to produce harshness in placing nor honeycombing in structures.

2. Watertightness of Concrete Work: It is intent of this Section to secure for every part of the Work, concrete and grout of homogeneous structure, which when hardened will have required strength, watertightness, and durability.
   a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
   b. Construction, contraction, and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of these expected cracks, due to normal expansion and contraction expected from specified concrete mixes.
   c. Class A and Class B Concrete: Watertight. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
   d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy injection system:
      1) Floors and walls of water bearing structures.
      2) Walls and slabs which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
      3) Epoxy used for Injection: Provide epoxy materials that are new and use them within shelf life limitations set forth by manufacturer. Water-insensitive 2 part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding the following characteristics when tested in accordance with standards specified Manufacturer:
         a) Master Builders, Inc., Concressive Standard LVI.
         b) Sika Chemical Corp.'s, Sikadur 35, Hi-Mod LV.
   e. Walls or Slabs, as Specified Above, That Leak or Sweat Because of porosity or Cracks too Small for Successful Pressure Grouting: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
   f. Grouting and Sealing: Continue as specified above until structure is watertight and remains watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.
3. Workmanship and Methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, Manuals, and Recommended Practices.

1.05 SUBMITTALS

A. Product Data: Submit data completely describing products.

B. Information on Heating Equipment to be Used for Cold Weather Concreting: Submit information on type of equipment to be used for heating materials and/or new concrete in process of curing during excessively cold weather.

C. For Conditions that Promote Rapid Drying of Freshly Placed Concrete Such as Low Humidity, High Temperature, and Wind: Submit corrective measures proposed for use prior to placing concrete.

D. Copies of Tests of Concrete Aggregates: Submit certified copies in triplicate of commercial laboratory tests of all samples concrete aggregates.
   1. On tests of concrete aggregates, indicate as minimum all specified tests.

E. Concrete Mixes: Prior to placement of concrete, submit full details, including mix design calculations for concrete mixes proposed for use for each class of concrete.
   1. Include information on correction of batching for varying moisture contents fo fine aggregate.
   2. Submit source quality test records with mix design submittal.

F. If there is Change in Aggregate Source, or Aggregate Quality from Same Source: Submit new set of design mixes covering each class of concrete.

G. Batch Test Data (from supplier):
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

H. Repair of defective concrete: Submit mix design for grout.

I. Acceptance of Method of Concrete Repair: Do not make any repairs until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

J. Quality Control Submittals:
   1. Certificates of Compliance:
      a) Cement: Submit certified copy of mill tests, including alkali content, representative of each shipment of cement for verification of compliance with specified requirements.
      b) Pozzolan:
         1) Submit certificates by Pozzolan supplier.
         2) Submit certificates that identify source of pozzolan and certify compliance with requirements of ASTM C 618.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing And Shipping:
   1. Deliver, store, and handle concrete materials in manner as to prevent damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.

3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at Site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Hot Weather Conditions:
      a. When Ambient Air Temperature is Above 90 Degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel by water cooling to below 90 degrees Fahrenheit.
      b. Temperature of Concrete Mix at Time of Placement: Keep temperature below 90 degrees Fahrenheit by methods which do not impair quality of concrete.
   2. Cold Weather Conditions:
      a. Concrete Placed Below Ambient Air Temperature of 40 degrees or Fahrenheit or below: Make provision for heating water.
      b. If Material Have Been Exposed to Freezing Temperatures to Degree That Any Material is Below 32 degrees Fahrenheit: Heat such materials.
      c. Heating Water, Cement, or Aggregate Materials:
         1) Do not heat in excess of 160 degrees Fahrenheit.
      d. Protection of Concrete in Forms:
         1) Protect by means of covering with tarpaulins, or other acceptable covering.
         2) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.
   3. For Conditions That Promote Rapid Drying of Freshly Placed Concrete Such As Low Humidity, High Temperature, and Wind: Take corrective measures to minimize rapid water loss from concrete:
      a. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, contraction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate:
1. General:
a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
b. Grade aggregate in accordance with ASTM D 75 and C 136.
c. Provide unit weight of fine and coarse aggregate which produces in place concrete with weight of not less than 140 pounds per cubic foot.

B. Fine Aggregate:
1. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
2. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances. In no case shall total exceed percent listed.

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C 117	3
Shale or Chert	ASTM C 295	1
Clay Lumps	ASTM C 142	1

3. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with requirements of ASTM C 33.

C. Coarse Aggregate:
1. General: Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
2. Weight: Not exceeding 15 percent, for thin or elongated pieces having length greater than 5 times average thickness.
3. Deleterious Substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C 295	1
Coal and Lignite	ASTM C 123	1/4
Clay lumps and friable particles	ASTM C 142	1/4
Materials finer than Number 200 sieve	ASTM C 117	½*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		

4. Grading:
    a. Aggregate: As specified in ASTM C 33, Size Number 57, except as otherwise specified or authorized in writing by the ENGINEER.
    b. Aggregate for Class CE Concrete for Encasement of Electrical Conduits:
        1) Graded as specified in ASTM C 33, Size Number 8.
        2) Provide concrete utilizing this aggregate equal to Class C concrete in all other respects, and is designated as Class CE.

D. Portland Cement:
1. General: Conform to specifications and tests for ASTM C 150, Types II or III, Low Alkali, except as specified otherwise.
2. Low Alkali Portland: Have total alkali containing not more than 0.60 percent.
3. Exposed Concrete in Any Individual Structure: Use only one brand of Portland cement.
4. Cement For Finishes: Provide cement from same source and of same type as concrete to be finished.

E. Portland-Pozzolan Cement:
1. General: Conform to requirements of ASTM C 595, Type IP (MS).
2. Portland Cement Clinker Used In Manufacture of Portland-Pozzolan Cement: Type II low alkali as specified in Paragraph 2.01D.
3. Pozzolan Content of Portland-Pozzolan Cement: Not exceed 15 percent by weight.
4. Exposed Concrete in Any Individual Structure: Use only one brand of portland-pozzolan cement.

F. Admixtures:
1. General:
    a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.
    b. Compatible with concrete and other admixtures.
    c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 5% by weight.
    d. Use in accordance with manufacturer's recommendations accordance with manufacture's recommendations and add each admixture to concrete mix separately.
    e. A single manufacturer shall provide all concrete admixtures.
2. Air Entraining Admixture:
    a. Provide all concrete with 5 percent, plus or minus 1 percent, entrained air of evenly dispersed air bubbles at time of placement.
    b. Conform to ASTM C 260.
3. Fly Ash Pozzolan Admixture:
    a. Pozzolan:
        1) Ad mixture shall conform to requirements of ASTM C618, Class F in concrete made with Type II portland cement.
        2) Pozzolan may replace portland cement at ratio of 1.0 pound fly ash for each pound of portland cement replaced.

3) Maximum of 20 percent by weight of minimum quantities of portland cement listed in Table A under paragraph 2.03E may be replaced with pozzolan.
4) Do not use pozzolan as an admixture in concrete made with portland-pozzolan cement.

b. Loss on Ignition for Pozzolan: Not exceed four percent.

4. Water Reducing Admixture:
   a. May be used at the CONTRACTOR's option in all areas.
   b. Conform to ASTM C 494, Type A or Type D.
   c. Not contain air entraining agents.
   d. Liquid form before adding to the concrete mix.
   e. No decrease in cement is permitted as result of use of water reducing admixture.
5. Superplasticizers: Are not to be used without acceptance by ENGINEER.

G. Water:
1. Water for Concrete, Washing Aggregate, and Curing Concrete: Clean and free from oil and deleterious amounts alkali, acid, organic matter, or other substances.
2. Chlorides and Sulfate Ions:
   a. Water for Conventional Reinforced Concrete: Use water not containing more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.

H. Nonslip Abrasive:
1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
2. Manufacturers: One of the following or equal:
   a. Exolon Company, Tonawanda, New York.
   b. Abrasive Materials, Incorporated, Hillsdale, Michigan.

I. Concrete Sealer:
1. Manufacturers: One of the following or equal:
   a. Hillyard Chemical Company, St. Joseph, Missouri, SEAL 341.
   b. A. C. Horn, Inc., Horn Clear Seal EM-180.

J. Conduit Encasement Coloring Agent:
1. Color: Red color concrete used for encasement of electrical ducts, conduits, similar type items.
2. Manufacturers: One of the following or equal.
   a. Davis Colors, Red Oxide Number 1117.

K. Keyway Material: Steel, plastic, or lumber.

L. Sprayed Membrane Curing Compound: Clear type with fugitive dye conforming to ASTM C 309, Type 1D, unless noted otherwise. After curing, and if subsequent coatings or toppings are specified, the curing compound shall be removed per manufacturer's recommendations.

M. Surface Sealant System: Manufacturers: One of the following or equal:
1. Tecnorap Radcon, Formula Number 7.
2. IPA Systems, Philadelphia, Pennsylvania, Duripal.

2.02 EQUIPMENT

A. Mixing Concrete:
1. Mixers may be of stationary plant, paver, or truck mixer type.
2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
3. Mixing Equipment:
a. Capable of combining aggregates, cement, and water within specified time into thoroughly mixed and uniform mass and of discharging mixture without segregation.
b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
c. Proportion cement and aggregate by weight.

B. Machine Mixing:
1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
2. If bulk cement is used, weigh it on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
3. Prevent cement from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
4. Procedure of mixing cement with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
5. Retempering of concrete will not be permitted.
6. Discharge entire batch before recharging.
7. Volume of Mixed Material Per Batch: Not exceed manufacturer's rated capacity of mixer.
8. Mixers:
a. Perform mixing in batch mixers of acceptable type.
b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing.
1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-Mixed Concrete:
   1. Mix and deliver in accordance with ASTM C 94.
   2. Total Elapsed Time Between Addition of Water at Batch Plant and Discharging Completed Mix: Not to exceed 90 minutes of elapsed time. At project site shall not exceed 30 minutes.
   3. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the ENGINEER.
   4. Equip Each truck mixer with device interlocked so as to prevent discharge of concrete from drum before required number of turns and furnish such device that is capable of counting number of revolutions of drum.
   5. Continuously revolve drum after it is once started until it has completely discharged its batch:
      a. Do not admit water until drum has started revolving.
      b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other Types of Mixers:
   1. In case of other types of mixers, mixing shall be as follows:
      a. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
      b. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
      c. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than one cubic yard increase minimum time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of Materials:
   1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the ENGINEER.
   2. Furnish apparatus for weighing aggregates and cement that is suitably designed and constructed for this purpose.
   3. Accuracy of Weighing Devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within on percent of desired amount of that material.
   4. Measuring or Weighing Devices: Subject to review by the OWNER, and bear valid seal of the Sealer of Weights and Measures having jurisdiction.
   5. Weighing Cement:
      a. Weigh cement separately.
      b. Cement in Unbroken Standard Packages (Sacks): Need not be weighed.
      c. Bulk Cement and Fractional Packages: Weigh such cement.
   6. Mixing Water: Measured by volume or by weight.

B. Concrete Proportions and Consistency:
   1. Concrete Consistency and Composition:
      a. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
      b. Prevent unnecessary or haphazard changes in consistency of concrete.
   2. Ratio of Coarse Aggregate to Fine Aggregate: Not less than 1.0 nor more than 2.0 for all concrete Classes, with exception of Class CE.
   3. Aggregate:
      a. Obtain aggregate from source which is capable of providing uniform quality, moisture content, and grading during any single day's operation.
   4. Concrete Mix Water to Cement Ratio, Minimum Cement Content, and Slump Range: Conform to values specified in Table A in this Section unless otherwise specified.
   5. Concrete Batch Weights: Control and adjust so as to secure maximum yield, and at all times maintain proportions of concrete mix within specified limits.
   6. Mixture Modification: If required, by the OWNER, modify mixture within limits set forth in this Section.

C. Concrete Mixes:
   1. Proportioning of Concrete Mix: Proportion mixes with required average compressive strength (f' cr) as defined in Subparagraph 2.04A.
   2. Mixes:
      a. Adjusting of Water: After acceptance, do not change mixes without acceptance by ENGINEER, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
      b. Total Water Content of Each Concrete Class: Not exceed those specified in Table A in this Section.
      c. Checking Moisture Content of Fine Aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
   3. Change in Mixes:
      a. Undertake new trial batch and test program as specified in this Section.
      b. Each New Trial Batch and Test Program: Cost of such trail batches and test program shall be borne by CONTRACTOR.

D. Hand Mixed Concrete:
   1. Perform hand mixing of concrete only when requested by the CONTRACTOR in writing and accepted by the OWNER.
   2. Prepare hand mixed concrete on watertight, level platform in batches not to exceed 1/3 cubic yard each.
   3. Aggregate:
      a. First spread required amount of coarse aggregate on platform in an even and uniform layer, and then over such aggregate spread proper proportion of fine aggregate.

b. Combined Depth of Both Such Layers: Not be greater than one foot.

4. Cement:
   a. First evenly spread required quantity of cement over fine aggregate.
   b. Then turn entire batch with shovels at least twice before adding water.
5. Water:
   a. Then uniformly sprinkle or spray proper amount of water over batched materials.
   b. Then turn with shovels not less than three times before being removing from platform.

E. Classes of Concrete:

1. Provide concrete consisting of six classes, referred herein as Classes A, AAA, B, C, D and CE specified in this Section and use where specified or indicated on the Drawings.
2. Weight of Concrete Classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
3. Class B Concrete: Class B concrete may be substituted for Class A concrete, if high-early strength concrete is desired by the CONTRACTOR, only in those areas specifically accepted by ENGINEER and which do not require sulfate resistant concrete.
4. Class C Concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
5. Class D Concrete: Use Class D for precast concrete items.
6. Class CE Concrete: Use Class CE for electrical conduit encasements.
7. All other concrete, unless specified or otherwise indicated on the Drawings: Use Class A concrete.

TABLE A - CONCRETE

Class	8.Specified Compressive Strength f'c at 28 Days (Pounds per Square Inch)	Maximum Net Water to Cement Ratio	Minimum Cement per Cubic Yard of Concrete by Weight (Pounds)	Slump Range (Inches)
A	4,000	0.53	564	2 to 4*
AAA	3,000	0.57	470	2 to 4*
B (Type III cement)	4,000	0.53	564	2 to 4*
C	2,500	0.71	423	3 to 6
D	4,500	0.45	658	2 to 4
CE	2,500	0.71	423	3 to 6

* NOTE: Slump for slabs, decks, walks, and beams shall be not more than 3-1/2 inches.

8. Pumped Concrete: Provide pumped concrete that complies with all requirements of this Section.
9. Do not place concrete with slump outside limits indicated in Table A.

10. Classes:
    a. Classes A, C, D, and CE Concrete: Make with Type II low alkali cement.
    b. Class B Concrete: Make with Type III low alkali cement.
    c. Admixtures: Provide admixtures as specified in this Section.

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. Concrete Mixes:
    a. After acceptance of concrete mixes, have trial batches of the accepted proposed concrete mix designs prepared by testing laboratory acceptable to the ENGINEER.
    b. Prepare trial batches by using specified cement and aggregates proposed to be used for the Work.
    c. Trial Batches: Provide batches of sufficient quantity to determine slump, workability, consistency and finishing characteristics, and to provide sufficient test cylinders.
    d. Test Cylinders: Provide cylinders having six inch diameter by 12 inch length and that are prepared in accordance with ASTM C 31 for tests specified in this Section.
    e. Determine slump in accordance with ASTM C 143.
    f. Test Cylinders:
        1) Test 4 cylinders for compressive strength in accordance with ASTM C 39:
            a) Test 1 cylinder at 7 days and 2 at 28 days.
            b) Establish ratio between 7 day and 28 day strength for mix. Seven day strength may be taken as satisfactory indication of 28 day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
        2) Average Compressive Strength of 2 Test Cylinders Tested at 28 Days: Equal to or greater than required average compressive strength f'cr on which concrete mix design is based.
2. Pozzolan:
    a. Sampling And Testing:
        1) Sample and test pozzolan in accordance with ASTM C 311.
        2) In Computing Water-Cement Ratio and Cement Content Per Cubic Yard of Concrete: Consider cement weight to be weight of portland cement plus 100 percent of weight of fly ash.
3. Aggregate:
    a. Testing of concrete aggregate is at CONTRACTOR's expense.
    b. Sieves:
        1) Use sieves with square openings for testing grading of aggregates.

2) Sieve Analysis: If sieve analyses indicate significant change in materials, the ENGINEER may require that new mix design be submitted and accepted before further placing of concrete.

c. Sample aggregate in accordance with ASTM D 75 and C 136.

d. Fine Aggregate:
   1) Provide fine aggregate not containing strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C 40.
   2) Provide aggregate having soundness complying with requirements of ASTM C 33 when tested in accordance with ASTM C 88.
   3) Provide aggregate complying with reactivity requirements of ASTM C 33 when tested in accordance with ASTM C 1260.

e. Coarse Aggregate:
   1) Soundness when tested in accordance with ASTM C 88: Have loss not greater than 10 percent when tested with sodium sulfate.
   2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131.
   3) Reactivity: Not exceed limits specified in Appendix of ASTM C 33 when tested in accordance with ASTM C 227.

f. Portland Cement:
   1) Determination Alkali Content: Determine by method set forth in ASTM C 114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conduit Encasement Concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

B. Joints and Bonding:
   1. As far as practicable construct concrete work as monolith.
   2. Locations of contraction, construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
   3. Construction Joints:
      a. Where construction joints are not indicated on the Drawings, provide slabs and walls with construction joints at intervals not greater than 30 feet.
      b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized by the ENGINEER.
      c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compound, mortar droppings, or other objectionable matter by means of sandblasting, and wash surfaces just prior to succeeding concrete placement.

d. At Horizontal Joints: Immediately prior to resuming concrete placing operations, thoroughly spread bed of grout not less than ½ inch in thickness nor more than 1 inch in thickness over horizontal joint surfaces.

4. Keyways in Joints:
   a. Provide keyways in joints as indicated on the Drawings.
   b. Treat lumber keyway material with form release coating, applied in accordance with manufacture's instructions.
5. Take special care to ensure that concrete is well consolidated around and against waterstops and that waterstops are secured in proper position.
6. Cleaning of Construction Joints:
   a. Wash construction joints free of sawdust, chips, and other debris after forms and built and immediately before concrete or grout placement.
   b. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
   c. Provide cleanout hole at base of each wall and column for inspection and cleaning.
7. Expansion, Contraction, and Construction Joints:
   a. Constructed where and as indicated on the Drawings.
   b. Expansion Joint Material, Synthetic Rubber Sealing Compound, and Other Similar Materials: As specified in Section 07900.
8. Repair of Concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent as specified in Section 03301.

C. Conveying and Placing Concrete:
1. Convey concrete from mixer to place of final deposit by methods which prevent separation or loss of materials.
2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without separation of materials.
3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

D. Delivery of Concrete:
1. Delivery time of concrete from batch to site of placement shall not exceed 90 minutes at 90° F. The ENGINEER has the right to reject the load if it fails to meet this criteria.

E. Placing Concrete:
1. Do not place concrete without prior authorization of the ENGINEER.

2. Do not place concrete until:
    a. Reinforcement is securely and properly fastened in its correct position and loose form ties at construction joints have been retightened.
    b. Dowels, bucks, sleeves, hangers, pipes, conduits, bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
    c. Forms have been cleaned and oiled prior to placement around rebar so as to prevent form oil from pelting on rebar.
3. Placement of concrete in which initial set has occurred, or of retempered concrete, will not be permitted.
4. Do not place concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested by the CONTRACTOR and accepted by the ENGINEER.
8. Notify the ENGINEER in writing of readiness, not just intention, to place concrete in any portion of the work:
    a. Provide this notification in such time in advance of operations as the ENGINEER deems necessary to make final inspection of preparations at location of proposed concrete placing.
    b. Place forms, steel, screeds, anchors, ties, and inserts in place before notification of readiness is given to the ENGINEER.
    c. Depositing Concrete:
        1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
        2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
        3) Do not drop concrete freely into place from height greater than 4 feet.
        4) Use tremies for placing concrete on slopes, at bottom of slope.
        5) Commence placement of concrete on slopes, at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached. The ENGINEER reserves the right to reject the placement if a cold joint is determined to affect the structural integrity.
11. If more than 20 minutes lapse prior to placement of new concrete over concrete previously places, reduce depth of layers being placed at one time, and/or increase placing operation to previously placed concrete within 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes have elapsed, then spread layer of grout not less than ½ inch in

thickness nor more than 1 inch in thickness over surface before placing additional concrete.

13. Placement of Concrete for Slabs, Beams, or Walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than one hour for shrinkage.

F. Consolidating Concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
    c. Do not place concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms so as to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth, and if for any way defective, repair such concrete in manner acceptable to the ENGINEER.

G. Footings and Slabs on Grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the ENGINEER.
2. If necessary, sprinkle subgrade with water not less than 6 nor more than 20 hours in advance of placing concrete.
3. If it becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
4. Do not place concrete if subgrade is muddy or soft.

H. Curing Concrete - General:
1. Cure concrete by methods specified in this Section.
2. Cure concrete minimum of 7 days.
3. Cure concrete that is to be painted or coated with water or plastic membrane.
4. Do not use curing compound on any concrete surface that is to receive paint or upon which any material is to be bonded.
5. Water cure or plastic membrane cure concrete slabs which are specified to be sealed by concrete sealer.
6. Cure other concrete by water curing or sprayed curing membrane at the CONTRACTOR’s option.

I. Water Curing:
   1. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
   2. Each day forms remain in place may count as 1 day of water curing.
   3. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
   4. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
   5. Flood top of walls with water at least 3 times per day, and keep concrete surfaces moist at all times during 7 day curing period.

J. Sprayed Membrane Curing:
   1. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   2. If more than one hour elapses after removal forms, do not use membrane curing compound, but apply water curing for full curing period.
   3. If surface requires repairing or painting, water cure such concrete surfaces.
   4. Curing Compound:
      a. Do not remove curing compound from concrete in less than 7 days.
      b. Curing compound may be removed only upon written required by the CONTRACTOR and acceptance by the ENGINEER, stating what measures are to be performed to adequately cure structures.
      c. Take care to apply curing compound in area of construction joints to see that curing compound is placed within construction joint silhouette.
      d. Remove curing compound placed within construction joint silhouette by heavy sandblasting prior to placing any new concrete:
         1) CONTRACTOR's Option: Instead of using curing compound for curing of construction joints such joints may be water cured.
      e. Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
      f. Apply compound in at least 2 coats.
      g. Apply each coat in direction 90 degrees to preceding coat.
      h. Apply compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
      i. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
      j. Thickness And Coverage Of Compound: Provide compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
      k. The CONTRACTOR is cautioned that method of applying curing compound specified herein may require more compound than normally suggested by manufacturer of compound and also more than is customary in the trade.

l. Apply amounts specified herein, regardless of manufacturer's recommendations or customary practice, if curing compound is used in place of water curing.

m. If the CONTRACTOR desires to use curing compound other than specified compound, coat sample areas of concrete wall with proposed compound and also similar adjacent area with specified compound in specified manner for comparison:

1) If proposed sample is not equal or better, in opinion of the ENGINEER, in all features, proposed substitution will not be allowed.

n. Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

K. Plastic Membrane Curing:

1. Polyethylene film may be used to cure slabs. Seal joint and edges with small sand berm.
2. Install plastic membrane as soon as concrete is finished and can be walked on without damage. Keep concrete moist under plastic membrane.

3.02 CONCRETE FINISHING

A. Provide smooth troweled finish for all process basins and containment structures.

B. Edges of Joints:

1. Provide joints having edges as indicated on the Drawings.
2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

3.03 FIELD QUALITY CONTROL

A. Testing of Concrete:

1. During progress of construction, the CONTRACTOR shall have tests made to determine whether the concrete, as being produced, complies with requirements specified.
2. Tests will be performed in accordance with ASTM C 31, ASTM C 39, and ASTM C 172.
3. The testing laboratory will make and deliver test cylinders to the laboratory and testing expense will be borne by the CONTRACTOR.
4. Required Number Cylinders:
   a. Not less than two cylinder specimens, 6 inch diameter by 12 inch long, will be tested for each 150 cubic yards of each class of concrete with minimum of two specimens for each class of concrete placed and not less than two specimens for each half day's placement.
   b. One cylinder will be broken at 7 days and one at 28 days.

5. The CONTRACTOR shall:
    a. Test slump of concrete using slump cone in accordance with requirements of ASTM C 143.
    b. Furnish test equipment.
    c. Do not use concrete that does not meet specification requirements in regards to slump, but remove such concrete from project site.
    d. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to so by the ENGINEER.
    e. Make provisions for and furnish concrete for test specimens, and provide manual assistance to the testing laboratory in preparing said specimens.
    f. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C 31.

B. Air Entraining Admixture:
    a. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified ranges, and when requested to do so by the ENGINEER.
    b. Provide test equipment.
    c. Do not use concrete that does not meet Specification requirements as to air entrainment and shall remove such concrete from project site.
    d. Test air entrainment in concrete in accordance with ASTM C 173.

C. Enforcement of Strength Requirement:
    1. Concrete is expected to reach higher compressive strength than that which is indicated in Table A as specified compressive strength f'c.
    2. Strength Level of Concrete: Will be considered acceptable if following conditions are satisfied.
        a. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength f'c.
        b. No individual strength test (average of 2 cylinders) falls below specified compressive strength f'c by more than 500 pounds per square inch.
        c. Whenever one, or both, of 2 conditions stated above is not satisfied, provide additional curing of affected portion followed by cores taken in accordance with ASTM C 42 and ACI 318 and comply with following requirements:
            1) If additional curing does not bring average of 3 cores taken in affected area to at least specified compressive strength f'c, designate such concrete in affected areas defective.
            2) The ENGINEER may require the CONTRACTOR to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all of the CONTRACTOR's expense.

3.04 ADJUSTING

A. Repair of Defective Concrete:
   1. Remove and replace or repair defective work.
   2. Correct defective work as specified in this Article.
   3. Do not patch, repair, or cover defective work without inspection by the ENGINEER.
   4. Provide repairs having strength equal or greater than specified concrete for area involved:
      a. Chip out and key imperfections in the work and make them ready for repair.
   5. Dry-Pack Method:
      a. Dry Pack Method: Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt, and narrow slots cut for repair.
      b. Smooth Holes: Clean and roughen by heavy sandblasting before repair.
   6. Mortar Method of Replacement: Use for following:
      a. Holes too wide to dry pack and too shallow for concrete replacement.
      b. Comparatively shallow depressions, large or small, which extend no deeper than reinforcement nearest surface.
   7. Concrete Replacement:
      a. Use: When holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
      b. Method of Repair For Surfaces of Set Concrete to be Repaired: First coat with epoxy bonding agent.
   8. Acceptable Method of Concrete Repair:
      a. Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Concrete mortar, grout, drypack mortar, nonshrink grout, and epoxy grout..

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 109 - Standard Test Method for Comprehensive Strength of Hydraulic Cement Mortars.
   2. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   3. C 191 - Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
   4. C 827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

B. U. S. Corps of Engineers (USCE):
   1. CRD C-621 - Corps of Engineers Specification for Non-Shrink Grout.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete Mortar:
   1. General: Consist of concrete mixture with coarse aggregate removed and water quantity adjusted as required.
   2. At Exposed Concrete Surfaces not to be Painted or Submerged in Water: White cement.

B. Grout:
   1. Consist of mixture of Portland Cement and sand.

C. Dry-Pack Mortar:
   1. Consist of mixture of Portland cement and sand.

D. Non-Shrink Grout:
   1. Consist of hydraulic cement, which when mixed with water hardens rapidly to produce permanent high strength material suitable for exterior use.
   2. Nonmetallic and not contain calcium chloride or other chemicals which accelerate corrosion of embedded steel.
   3. Physical Characteristics:
      a) When Tested in Accordance with ASTM C 827: Show no shrinkage prior to initial setting.
      b) When Tested in Accordance with ASTM C 157 and Corps of Engineers CRD C-621: Show no shrinkage in hardened state.
   4. Manufacturers: One of the following or pre-approved equal:
      a) Master Builders, Inc., Masterflow 928 Grout.

E. Epoxy Grout:
   1. Consist of mixture of epoxy and sand.
   2. Sand: Clean, bagged, graded, and kiln dried silica sand.

2.02 MIXES

A. Concrete Mortar Mix:
   1. Use water-cement ratio that is no more than that specified for concrete being repaired.
   2. At Exposed Concrete Surfaces not to be Painted or Submerged in Water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

B. Grout Mix:
   1. For Concrete Repair: Mix in same proportions used for concrete being repaired, with only sufficient water to give required consistency for spreading.
   2. For Spreading over the Surfaces of Construction or Cold Joints: Mix with no more water used than allowed by water-cement ratio specified for concrete.
   3. For grout not specified in subparagraph 2.02B1 or 2.02B2, mix in proportions by weight of one part cement to four part of concrete sand.

C. Dry-Pack Mortar Mix: Use only enough water so that resulting mortar will crumble to touch afer being formed into ball by hand.

D. Non-Shrink Grout: Mix accordance with manufacturer's installation instructions such that resulting mix has semi-fluid, flowable consistency and is suitable for placing by pouring.

E. Epoxy Grout:
   1. Mix in accordance with manufacturer's installation instructions for mixing.

2. Proportioning:
    a. For horizontal work, consist of mixture of one part epoxy as specified in Section 03301 with not more than 2 parts sand.
    b. For vertical or overhead work, consist of 1 part epoxy gel as specified in Section 03301 with not more than 2 parts sand.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface Preparation:
    1. Concrete Surfaces: Clean and roughen by heavy sandblasting. For Portland Cement based mortars and grouts, concrete shall be saturated and surface damp before mortar or grout is placed.
    2. Epoxy Grout:
        a. Wet contact surface with prepared grout as required to provide proper adhesion.
        b. Where required to wet the concrete surfaces, apply coat of epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.

3.02 APPLICATION

A. Cement Mortar and Grout:
    1. For Imperfect Concrete Repair:
        a. Filling: Filling of voids around items through the concrete.
        b. Grout Spreading: Spread over construction joints, cold joints, and similar type items.
    2. Concrete Surfaces:
        a. Apply epoxy bonding agent to clean, roughened, and dry surface before placing mortar or grout.
    3. Placing:
        a. Exercise particular care in placing portland cement mortar or grout since they are required to furnish structural strength or impermeable water seal or both.
        b. Do not use cement mortar or grout that as not been placed within 30 minutes after mixing.

B. Epoxy Grout:
    1. Apply in accordance with manufacturer's installation instructions.
    2. Use where specified herein or where indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Tests:

1. Non-Shrink Grout:

a. A set of three specimens shall be made for testing. One at seven days, one at 25 days, and the third of a later date if needed.

b. Compression test specimens shall be taken during construction from the first day of placement of grout.

c. The costs of all laboratory tests shall be borne by the CONTRACTOR.

d. Compressive Strength When Tested In Accordance With ASTM C 109:

1) At One Day: Not less than 3,000 pounds per square inch. At 28 days: Not less than 6,000 pounds per square inch.

e. Setting Time when Tested In Accordance with ASTM C 191: Not less than 30 minutes.

END OF SECTION

DIVISION 5

METALS

SECTION 05052

ANCHOR BOLTS, TOGGLE BOLTS AND CONCRETE INSERTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install anchor bolts, toggle bolts and concrete inserts.

B. This Section includes all anchor bolts, toggles and inserts required for the Work, but not specified under other Sections.

C. The types of Work using the anchor bolts, toggles and inserts include, but are not limited to the following:
   1. Hangers and brackets.
   2. Equipment.
   3. Piping.
   4. Grating and floor plate.
   5. Electrical and Plumbing Work.
   6. Metal and plastic fabrications.
   7. Structural members and accessories.

D. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessary limited to, Work that is directly related to this Section.
   1. Section 05501 - Miscellaneous Metals.

1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified.
   1. ASTM A 36 - Specification for Carbon Structural Steel.
   2. ASTM A 123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM A 153 - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   5. ASTM A 484 - Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
   6. ASTM A 536 - Specification for Ductile Iron Castings.

7. ASTM B 633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
8. ASTM F 593 - Stainless Steel Bolts; Hex Cap Screws, and Studs.
9. Federal Specification FF-S-325 for Concrete Expansion Anchors.
10. Federal Specifications WW-H-171E for Malleable Iron.
11. ICBO, International Conference of Building Officials.
12. International Building Code

B. Inserts shall be ICBO, UL or FM approved.

C. Toggle Bolts: Federal Specification FF-B-588C - Type I, Class A, Style 1.

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices.
2. Copies of ICBO, UL or FM Reports certifying load carrying capacities and installation requirements for the anchorage devices.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

A. When the size, length or load carrying capacity of an anchor bolt, toggle bolt, or concrete insert is not shown on the Drawings, provide the following:
1. For anchor bolts (cast-in-place), provide the size, length and capacity required to carry the design load based on the values and requirements given in the International Building Code.
2. For concrete anchors (epoxy adhesive types), stud type expansion anchors, and concrete inserts, provide the size, length, type, and capacity required to carry the design load based on the values and requirements given in the ICBO Evaluation Report, or similar certifications by UL or FM, for the anchor to be used. Alternately the capacity may be based on independent testing lab capacities for tension and shear strength using a minimum safety factor of four. Consideration of reduced capacity due to spacing and edge distance shall be made.

B. Determine design loads as follows:
1. For equipment anchors, use the design load recommended by the equipment manufacturer.
2. For pipe hangers and supports, use the total weight of: pipe, fittings, and water contained in pipe, plus the full weight of valves and accessories located between the hanger or support in question.
3. Allowances for vibration shall be included.
4. Concrete anchors shall develop ultimate shear and pull-out loads of not less than the following values in 4,000 psi concrete:

Bolt Diameter (Inches)	Min. Shear (Pounds)	Min. Pull-Out Load (Pounds)
½	5,000	7,600
5/8	8,000	12,000
3/4	11,500	17,000
7/8	15,700	20,400
1	20,500	28,400

2.02 APPLICATION

A. In masonry, only anchor bolts shall be used.

B. Anchor Bolts (cast-in-place):
1. Shall be used where indicated and may be used where concrete anchors are indicated.
2. Where an anchor bolt is indicated, only a cast-in-place anchor bolt shall be used, unless another anchor type is accepted by the ENGINEER.
3. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry and equipment to concrete pads and bases.

C. Epoxy Adhesive Anchors:
1. Use where subject to vibration or where buried or submerged.
2. Use for pipe supports.
3. Use in concrete.
4. Shall not be used for pipe hangers.

D. Concrete Inserts:
1. Use only where indicated on the Drawings.
2. Use for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

E. Toggle Bolts:
1. Use for fastening brackets and other elements onto masonry units.

F. Stud Type Expansion Anchors:
1. Use only when indicted on the Drawings.

2.03 MATERIALS

A. Anchor Bolts:
1. Provide carbon steel bolts complying with ASTM A 307 - headed or non-headed type where indicated.
2. In buried or submerged locations, provide stainless steel bolts complete with washers complying with ASTM F 593 - AISI Type 316 and with nitronic 60 stainless steel nuts and locknuts.

3. For equipment, provide anchor bolts, which meet the equipment manufacturer's recommendations for size, material, and strength.
4. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.
5. Locate and accurately set the anchor bolts using templates or other devices as required.
6. Protect threads and shank from damage during installation of equipment and structural steel.
7. Comply with manufacturer's required embedment length and necessary anchor bolt projection.

B. Epoxy Adhesive Anchors:
1. Provide stainless steel adhesive anchors complying with ASTM F 593 - AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
2. In buried or submerged locations, provide stainless steel adhesive anchors complying with ASTM F 593 - AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
3. Anchors shall be of the size required for the concrete strength specified.
4. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt, unless noted otherwise on the Drawings.
5. Product and Manufacturer: Provide one of the following:
   a. RE 500 Epoxy Injection Adhesive Anchor System, as manufactured by Hilti.
   b. Or pre-approved equal.

C. Concrete Inserts:
1. For piping, grating and floor plate, provide malleable iron inserts. Comply with Federal Specification WW-H-171E (Type 18). Provide those recommended by the manufacturer for the required loading.
2. Finish shall be black.
3. Product and Manufacturer: Provide inserts by one of the following:
   a. Figure 282, as manufactured by ITT Grinnell.
   b. No. 380, as manufactured by Hohmann and Barnard, Incorporated.
   c. Or pre-approved equal.

D. Toggle Bolts:
1. Provide spring-wing toggle bolts, with two-piece wings.
2. Provide carbon steel bolts with zinc coating in accordance with Federal Specification FF-S-325.
3. Product and Manufacturer: Provide toggle bolts by one of the following:
   a. The Rawlplug Company, Incorporated.
   b. Haydon Bolts, Incorporated.
   c. Or pre-approved equal.

E. Stud Type Expansion Anchors:
   1. Product and manufacturer:
      a. Kwik-Bolt 3.
      b. Or pre-approved equal.

F. Powder activated fasteners and other types of bolts and fasteners not specified herein shall not be used.

PART 3 EXECUTION

3.01 INSPECTION

A. CONTRACTOR shall examine areas and conditions under which anchor bolts, toggle bolts and concrete insert Work is to be installed.

3.02 INSTALLATION

A. Assure that embedded items are protected from damage and are not filled in with concrete.

B. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

C. Use toggle bolts for fastening brackets and other elements onto masonry units.

D. For the epoxy adhesive anchors and adhesive material, CONTRACTOR shall comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the adhesive anchor or reinforcing bar. Contractor shall properly clean out the hole utilizing a wire brush and compressed air to remove all loose material from the hole, prior to installing adhesive capsules or material.

3.03 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

END OF SECTION

SECTION 05501

MISCELLANEOUS METALS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Miscellaneous metal fabrications including:
   1. Miscellaneous aluminum.
   2. Miscellaneous cast iron.
   3. Miscellaneous stainless steel.
   4. Miscellaneous structural steel.
   5. Miscellaneous carbon steel.
   6. Associated accessories to the above items.

B. Related Sections:
   1. Section 05052 - Anchor Bolts, Toggle Bolts, and Concrete Inserts.
   2. Section 09800 - Special Coatings.
   3. Section 09900 - Painting.

C. See Drawings.

1.02 REFERENCES

A. Aluminum Association (AA) - Specification M32-C22-A41 - Aluminum Finishes.

B. ANSI A12.1 - Safety Requirements for Floor and Wall Openings, Railings, and Toeboards.

C. American Society for Testing and Materials (ASTM):
   1. A 36/A 36M - Specification for Structural Steel.
   2. A 48 - Specification for Grey Iron Castings.
   3. A 53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   4. A 123 - Specification for Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products.
   5. A 167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   6. A 269 - Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   7. A 276 - Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
   8. A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 per square inch Tensile.
   9. A 325 - Specification for High-Strength Bolts for Structural Steel Joints.

10. A 489 - Specification for Carbon Steel Eyebolts.
11. A 490 - Specification for Heat-Treated, Steel Structural Bolts, 150 ksi Tensile Strength.
12. A 500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. A 501 - Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
14. A 554 - Specification for Welded Stainless Steel Mechanical Tubing.
15. A 635/A 635M - Specification for Steel, Sheet and Strip, Heavy Thickness Coils Carbon, Hot-Rolled.
16. A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-iron Alloy-coated (Galvanized) by the Hot-Dip Process.
17. B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
18. B 429 - Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. B 308 - Specification for Aluminum Alloy 6061-T6 Standard Structural Profiles.
20. B 221 - Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

D. AWS D 1.1 - Structural Welding Code.

E. OSHA Part 1910.23 - Guarding Floor and Wall Openings and Holes.

F. International Building Code (IBC).

1.03 SUBMITTALS

A. Shop Drawings: Submit fabrication drawings for approval.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals shall conform with the standards of the American Society for Testing and Materials, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast Iron	A 48	Class 40B
Steel		
Galvanized sheet iron or steel	A 653	Coating G90
Black steel, sheet or strip	A 569	–
Coil (plate)	A 635	–
Structural plate, bars, rolled shapes, and	A 36	–
Standard bolts, nuts, and washers	A 307	–
High strength bolts, nuts and hardened flat washers	A 325, A 490	–
Eyebolts	A 489	Type 1
Tubing, cold-formed	A 500	–
Tubing, hot-formed	A 501	–
Steel pipe	A 53	Grade B
Stainless Steel		
Plate, sheet and strip	A 167	Type 304 or 316*
Bars and shapes	A 276	Type 304 or 316*
Aluminum		
Sheet aluminum-flashing	B 209	Alloy 5005-H14, 0.032 inches minimum thickness
Sheet aluminum-structural	B 209	Alloy 6061-T6
Structural aluminum	B 308 B 209	Alloy 6061-T6
Extruded aluminum	B 221	Alloy 6063-T42
* Use Type 304L or Type 316L if material will be welded.		

B. Stainless steels are designated by type or series defined by ASTM.

C. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MISCELLANEOUS ALUMINUM

A. General: Fabricate aluminum products, not covered separately herein, in accordance with the best practices of the trade and field assemble by riveting or bolting. Do not weld or flame cut.

2.03 MISCELLANEOUS CAST IRON

A. General:

1. Tough, gray iron, free from cracks, holes, swells, and cold shuts.

2. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
3. Before leaving the foundry, clean castings and apply 16 mil dry film thickness coating of coal-tar epoxy, unless otherwise specified in or indicated on the Drawings.

2.04 MISCELLANEOUS STAINLESS STEEL

A. Provide miscellaneous stainless steel items not specified herein as indicated on the Drawings or specified elsewhere. Fabricate and install in accordance with the best practices of the trade.

2.05 MISCELLANEOUS STRUCTURAL STEEL

A. Provide miscellaneous steel items not specified herein as indicted on the Drawings or specified elsewhere. Fabricate and install in accordance with the best practices of the trade.

2.06 LADDERS

A. General:
1. Type: Safety type conforming to local, State, or Occupational Safety and Health Administration standards as minimum. Furnish guards for ladder wells.
2. Size: Minimum 16 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.

B. Aluminum Ladder:
1. Material shall be 6061-T6 Aluminum and anodized.
2. Ladder shall conform to OSHA Standard 1910.27.
3. Rungs shall have serrated surface for slip resistance.
4. 1-1/4" solid serrated safety rung designed to meet loading standards which are 4 times that which is recommended by OSHA Standard #1910.27.
5. Ladder Up Safety Post where shown: Factory assembled telescoping post, designed for mounting fixed ladder, complete with brackets, hardware, and fasteners.
   a. Material Finish: Aluminum mill finish.
   b. Product and Manufacturer: Model LU-4, The Bilco Company or pre-approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, dot not begin this Work until such conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.

3.03 LADDERS

A. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.

B. Where exit from ladder is forward over top rung, extend side rails 3 feet 6 inches minimum above landing, and return the rails with a radius bend to the landing.

C. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.

D. Erect rail straight, level, plumb, and true to position indicated on the Drawings. Correct deviations from true line or grade which is visible to the eye.

E. Ladders to be fabricated of aluminum, unless noted otherwise.

3.04 MISCELLANEOUS ALUMINUM

A. Coat aluminum angles cast into concrete with bituminous materials.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09800

SPECIAL COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: All factory applied and field applied coatings shall follow the provisions of this Section unless other coating requirements are referenced in other specific equipment specification sections. Equipment vendors shall conform to this specification section for factory applied coatings. All exposed surfaces of process equipment, piping, supports, electrical conduit (interior and exterior) and other materials shall be shop primed and field finished, unless specifically stated otherwise.

B. See Drawings.

1.02 REFERENCES

A. National Sanitation Foundation (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

B. American National Standards Institute (ANSI):
   1. A159.1 - Surface Preparation Specifications.

C. American Society for Testing and Materials (ASTM):
   1. D 16 - Standard Terminology for Paint, Related Coatings, Materials and Application.
   2. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. National Fire Protection Association (NFPA):
   1. 101 - Life Safety Code.

E. The Society for Protective Coatings (SSPC):
   1. SP 1 - Solvent Cleaning.
   2. SP 2 - Hand Tool Cleaning.
   3. SP 3 - Power Tool Cleaning.
   4. SP 6 - Commercial Blast Cleaning.
   5. SP 7 - Brush-off Blast Cleaning.
   6. PA2 Level 3 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   13. PA Guide 10 - Guide to Safety and Health Requirements for Industrial Painting Projects.
   14. Guide 6 - Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations.
   15. Guide 12 - Guide for Illumination of Industrial Painting Projects.

F. National Association of Corrosion Engineers (NACE International)
   1. Publication 6D-173-A Manual for Painter Safety.

1.03 DEFINITIONS

A. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.

B. Submerged Concrete Surfaces: Surfaces which are or will be:
   1. Underwater.
   2. In structures which normally contain water.
   3. Below tops of walls or water containing structures.

C. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils.

D. Wet Film Thickness (WFT): Thickness of freshly applied coating, measured in mils (1/1000 inch).

E. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating products measured in units of grams per liter or pounds per gallon.

F. Rust Spot: Rusted surface with area smaller than 0.05 SQ.FT.

G. Installer or Applicator: Installer or applicator is the person actually installing or applying the product in the field at the Project site. Installer or applicator are synonymous. Installer or Applicator may be the CONTRACTOR.

H. Inaccessible Areas: Areas of the finished structure that, by virtue of the configuration of the completed structure, cannot be accessed to perform surface preparation or coating application (with or without the use of scaffolding, rigging, or staging).

I. Holiday: A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating. May also be identified as a pinhole.

J. Touch-Up Coating: The application of a coating on areas of coated surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

K. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site, where the field or finishing coat is applied.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials for concrete and metal surfaces shall be especially adapted for use in water treatment plants.

B. Coating materials that come into contact with potable water shall be certified to NSF 61.

1.05 SUBMITTALS

A. Product Data: Submit in accordance with Sections 01340.

B. Certificates: Submit in accordance with Article 1.06.

C. Manufacturer's Instructions: Submit in accordance with requirements for Product Data and Section 09900.

1.06 QUALITY ASSURANCE

A. Qualifications of Applicator:
1. Minimum of five years experience applying specified products or similar type products under the conditions similar to those of the Work.
2. Manufacturer approved applicator when manufacturer has approved applicator program.
3. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
4. CONTRACTOR is completely responsible to insure that applicator personnel are completely trained and experienced in the proper use of all specified/submitted coating and lining materials, surface preparation and application equipment being used for the project.

B. Regulatory Requirements: Include requirements concerning the following:
1. Volatile organic compound limitations.
2. Coatings containing lead compounds.
3. Abrasives and abrasive blast cleaning techniques, and disposal.
4. NSF certification of coatings for use in potable water supply systems.

C. Compatibility of Coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

D. If any requirements of this specification conflict with a referenced standard, the more stringent requirement shall apply.

E. Do not use or retain contaminated, outdated, or diluted materials for coating operations. Do not use materials from previously opened containers.

F. Use only products of the approved manufacturer. Use products of one manufacturer in any one resurfacing system with compatible materials. Provide same material product for touch up as for original material.

G. Make available all locations and phases of the work for access by the ENGINEER or other personnel designated by the ENGINEER. The CONTRACTOR shall provide ventilation and egress to safely access the coating work areas for inspection.

1.07 PROJECT CONDITIONS

A. Regulatory Requirements:
1. Conform to applicable codes for flame and smoke rating and VOC requirements for products and finishes.
2. Comply with governing code requirements for air quality and material disposal regulations.
3. Coatings for surfaces in contact with potable water or water being treated for potable use shall not impart any taste or odor to the water or result in any organic or inorganic content in excess of the maximum containment level established by applicable laws or regulations.

1.08 MAINTENANCE

A. Extra Materials: Provide one extra gallon of each type of coating.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. P = prime coat. I = intermediate coat. F = finish coat. Finish color to be selected by OWNER.
2. All coatings and products for each coating system shall be the product of a single coating manufacturer.
3. All materials brought to the jobsite shall be subject to inspection by ENGINEER.
4. Only full kits of approved coating shall be mixed. No partial kits will be saved or mixed at a later time.
5. All coating materials used must not contain more than 3.5 LBS/GAL VOC as applied (in a thinned state).
6. Coating thicknesses specified are minimum dry mil thicknesses.

B. Acceptable Manufacturers
1. Following are acceptable coating manufacturers:
a. Tnemec Coatings.
b. Carboline
c. Or pre-approved “Or Equal”.

C. Coating Systems (not all system numbers are used):
1. System No. 1 - Polyamide Epoxy: For all assembled galvanized steel items; and all plastic including PVC, FRP, and CPVC surfaces. Exposed PVC and CPVC piping shall be painted.
a. Items may include PVC, FRP and CPVC piping.

P1 = Series 66 (gray), 1 coat, 3-5 mils DFT.
*F1 = Series 66 (white), 1 coat, 4-6 mils DFT.
F1E = Series 73 (beige), 1 coat, 2.5 - 3.5 mils DFT.

PART 3 EXECUTION

3.01 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements follow.

B. Protect following surfaces from abrasive blasting by masking, or other means:
   1. Surfaces to be assembled against gaskets.
   2. Aluminum ladders, handrails and platforms (if applicable).
   3. Field instruments like pressure gauges, pressure sensors, flow meters, electrical panels, etc.

C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

D. Non-metallic surfaces: Prepare surface per manufacturer's recommendation.

3.02 GENERAL PROTECTION

A. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings.

B. Mask off surfaces of items not to be coated or remove items from area.

3.03 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

C. Apply minimum number of specified coats.

D. Apply coats to thicknesses specified, especially at edges and corners.

E. Apply additional coats when necessary to achieve specified thicknesses.

F. Coat surfaces without drops, ridges, waves, holiday, laps, or brush marks.

G. Remove spatter and droppings after completion of coating.

H. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.

I. Dust coatings between coats. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

J. Spray Application:
   1. When using spray application, apply coating to thickness not greater than that suggested in coating manufacturer's instructions.
   2. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
   3. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.

K. Drying and Recoating:
   1. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
   2. Do not allow excessive drying time or exposure which may impair bond between coats.
   3. Recoat epoxies within time limits recommended by epoxy manufacturer.
   4. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
   5. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
   6. Leave no holidays.
   7. Sand and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.

L. Dry film thickness (DFT) readings of the coating are to be taken to provide reasonable assurance that the specified minimum DFT has been achieved.

3.04 FIELD QUALITY CONTROL

A. Inspection will be performed prior to and following the abrasive blasting and following each coat. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.

B. Control and check dry film thicknesses and integrity of coatings.

C. Measure dry film thickness with calibrated thickness gauge.

D. Check dry film thicknesses with Elcometer 456 or Positector 6000.

E. Verify coat integrity with low-voltage holiday detector. Allow OWNER to use detector for additional checking.

F. Check wet film thickness before coal tar epoxy coating cures on concrete or non-ferrous metal substrates.

3.05 SCHEDULES OF ITEMS NOT REQUIRING COATING

A. Items that have received final coat at factory and not listed to receive coating in the field.

B. Brass, bronze, copper, plastic, rubber, stainless steel, chrome, everdur or lead.

C. Buried or encased piping or conduit.

D. Galvanized pipe trays and cable trays.

E. Grease fittings.

F. Steel to be encased in concrete or masonry.

G. Nameplates.

H. Serial number tags.

I. Control Panels and Instruments.

3.06 CLEANING

A. As work proceeds and upon completion, promptly remove coating where spilled, splashed, or spattered.

B. Adjacent painted surfaces shall be protected from discoloration, scratching or other damage. Any touch-up painting required to damaged areas prior to project completion and acceptance belongs to CONTRACTOR.

C. After the vessel interior surface is inspected and approved by the OWNER or ENGINEER, the final sterilization of said interior shall be done by the CONTRACTOR at no cost to the OWNER.

D. The CONTRACTOR shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by his employees or work. All unneeded construction equipment shall be removed from the site and all damages repaired expeditiously so that the adjacent property is inconvenienced as little as possible.

E. On or before the completion of work, the CONTRACTOR shall, unless otherwise directed in writing, remove all temporary works, tools and machinery or other construction equipment placed by him. He shall remove all rubbish from any grounds that he has occupied and shall leave all of the premises and adjacent property affected by the operation in a neat and restored condition satisfactory to the ENGINEER.

3.07 DISINFECTION

A. CONTRACTOR shall be responsible for vessel disinfection. Disinfection shall conform to all applicable requirements of AWWA C652, and as specified below.

B. After the vessel has been coated and interior surface has been thoroughly and properly cured, the inside of the vessel shall be thoroughly cleaned. Interior of the vessel shall be disinfected by spraying all surfaces, including lateral piping, shell and

roof manways, with a 200 ppm available chlorine solution. Solution shall remain in contact with surfaces for a minimum of 30 minutes. Technique shall be such that a sterile vessel will result. After spray disinfection, the vessel shall be filled to completely. Following this procedure and subject to satisfactory bacterial testing and acceptable aesthetic quality, the water shall be delivered to the distribution system.

C. The OWNER shall take a bacteria test of the water after disinfecting. If the water is considered not safe after testing, additional disinfecting and testing shall be performed by the CONTRACTOR at his expense until the vessel is tested safe for use as part of a potable water supply system.

D. The OWNER shall take a taste and odor test of the water after disinfecting to detect the presence of any volatile organic compounds (VOC's) imparted by the coating. If the water is not considered safe or acceptable after testing, further work shall be performed by the CONTRACTOR at his expense until the vessel is tested safe and acceptable for use as part of a potable water supply system.

E. Water for initial disinfection and filling and for any additional disinfection during the initial disinfection procedure to obtain satisfactory bacteriological samples, will be furnished by the OWNER. CONTRACTOR shall be responsible for all disinfection chemical required.

F. If the vessel must be emptied, re-sprayed, flushed and refilled to obtain satisfactory bacteriological samples, the OWNER will furnish additional water for the Work at the expense of CONTRACTOR. Additional disinfection chemical required costs shall belong to CONTRACTOR.

G. Supply all necessary pumps, hoses and other required equipment each time the vessel needs to be emptied.

3.08 FIRST ANNIVERSARY INSPECTION

A. Interior and exterior surfaces of the vessel shall be inspected by OWNER, ENGINEER and CONTRACTOR approximately 12 months after the coating work has been completed. Inspection, remedial work, if required, and report shall all be provided as required by AWWA D 102, Section 5.2.

B. OWNER will conduct the vessel interior inspection.

C. If any vessel interior coating remedial work has to be performed, CONTRACTOR shall be responsible for all costs associated with the coating remedial work and disinfection of the vessel.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Field applied paint and related materials for normal exposures.

B. Related Sections:
   1. Section 09800 - Special Coatings

1.02 DEFINITIONS

A. Paints: Manufacturer's best ready-mixed coatings, except when field catalyzed, with fully ground pigments having soft paste consistency and capable of being readily and uniformly dispersed to complete homogenous mixtures, having good flowing and brushing properties, and capable of drying or curing free of streaks or sags.

B. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating products measured in units of grams per liter or pounds per gallon.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340. Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.

B. Product Data: Submit in accordance with Section 01340. Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.

C. Samples: Submit in accordance with Section 01333. Include 8 inch square draw-downs or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.

D. Manufacturer's Instructions: Submit in accordance with requirements for Product Data. Include:
   1. Special requirements for transportation and storage.
   2. Mixing instructions.
   3. Shelf life.
   4. Pot life of material.

5. Precautions for applications free of defects.
6. Surface preparation.
7. Method of application.
8. Recommended number of coats.
9. Recommended thickness of each coat.
10. Recommended total thickness.
11. Drying time of each coat, including prime coat.
12. Required prime coat.
13. Compatible and non-compatible prime coats.
14. Recommended thinners, when recommended.
15. Limits of ambient conditions during and after application.
16. Time allowed between coats.
17. Required protection from sun, wind and other conditions.
18. Touch-up requirements and limitations.
19. Material Safety Data Sheet.

1.04 QUALITY ASSURANCE

A. Products: First line or best grade.

B. Materials for Each Paint System: By single manufacturer.

C. Applicator Qualifications: Applicator of products similar to specified products with minimum 5 years experience.

D. Regulatory Requirements: Comply with by using paints that do not exceed governing agency's VOC limits or do not contain lead.

E. Field Sample: Paint one complete surface of each color scheme to show colors, finish texture, materials and workmanship. Obtain approval before painting other surfaces.

1.05 PRODUCTS DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle products in accordance with Section 01651.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

D. Store coatings in well ventilated facility that provides protection from the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.06 ENVIRONMENTAL CONDITIONS

A. Do not paint or coat:
   1. Under dusty conditions.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 45 degrees Fahrenheit.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.
   7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
   8. Apply clear finishes at minimum 65 degrees Fahrenheit.

B. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface or substrate, coating between coats and within curing time following application of last coat.

C. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 45 degrees Fahrenheit for 24 hours before, during, and 48 hours after application of finishes.

1.07 PROTECTION

A. Protect adjacent surfaces from paint and damage. Repair damage resulting from inadequate or unsuitable protection.

B. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

C. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. Carefully store, clean and replace on completion of painting in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

1.08 EXTRA MATERIALS

A. Extra Materials: Include minimum 1 gallon of each type and color of coating applied.
   1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.

2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type and color.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Paints: One of the following or equal:
   1. Carboline: Carbonline, St. Louis, MO.
   2. Tnemec: Tnemec Co., Kansas City, MO.
   3. Or Pre-approved Equal.

PART 3 - EXECUTION

3.01 INSPECTION

A. Thoroughly examine surfaces scheduled to be painted before starting work.

B. Start painting when unsatisfactory conditions have been corrected.

3.02 PREPARATION OF SURFACES

A. Prepare surfaces in accordance with paint manufacturer's instructions or when none, the following.

B. Canvas and Cotton Insulation Coverings: Remove dirt, grease and oil.

C. Concrete: Remove dirt, loose mortar, scale, powder and other foreign matter. Remove oil and grease with solution of tri-sodium phosphate. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate. Rinse well and allow to thoroughly dry. Spot prime exposed metal with alkyd primer.

3.03 APPLICATIONS

A. Apply each coat at proper consistency.

B. Tint each coat of paint slightly darker than preceding coat.

C. Sand lightly between coats to achieve required finish.

D. Do not apply finishes on surfaces that are not sufficiently dry.

E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

3.04 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled splashed or spattered.

B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials and debris.

C. Upon completion of work leave premises neat and clean.

END OF SECTION

DIVISION 11

EQUIPMENT

SECTION 11002

EQUIPMENT IDENTIFICATION TAG SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals, as shown on the Drawings, specified and required to furnish and install an equipment identification tag system.
   2. The extent of the equipment identification tag system is specified herein and shown on the Drawings.
   3. The type of equipment identification tag system includes, but is not necessarily limited to, the following:
      a. Equipment identification tags.
      b. Miscellaneous mechanical fasteners.

B. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessarily limited to, Work that is directly related to this Section.
   1. Division 11 - Equipment.
   2. Division 15 - Mechanical.
   3. Division 16 - Electrical.
   4. Division 17 - Instrumentation and Controls.

C. Equipment Identification Tags:
   1. Equipment Identification Tags shall contain device numbers and name descriptions.
      a. Tag numbers shall consist of up to seven digits.
      b. Device descriptions shall consist of three to four lines with a maximum of 55 letters.
   2. Device numbers and name descriptions shall be furnished by the OWNER during construction.
   3. CONTRACTOR shall provide sufficient number of equipment tags to label all equipment requiring identification.

1.02 QUALITY ASSURANCE

A. Source Quality Control: Provide equipment identification tags by a single manufacturer.

1.03 SUBMITTALS

A. Samples: Submit for approval samples for color and finish of materials and accessories required for the equipment identification tag system. ENGINEER'S review of samples will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. List of all devices including tag number with device and signal name description.
   2. Anchorage and accessory items.
   3. Samples of actual equipment identification tags for five devices.

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION TAGS

A. Tags shall be 1-inch by 3-inches with two 1/8-inch holes centered on each end of the tag. Tags shall be made from aluminum 0.020-inch thick and coated with black enamel paint.

B. Each tag shall be engraved with the equipment identification number and description as shown on the Drawings or as specified. The engraving print shall be 1/4-inch Gothic.

C. Each tag shall be attached with fasteners of nylon coated, 48-mil, stainless steel wire as manufactured by Brady or equal and brass double ferrule wire clamps, as manufactured by Brady or equal, to secure the stainless steel wire.

PART 3 - EXECUTION

3.01 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates and conditions under which the equipment identification tags are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.02 INSTALLATION

A. Install equipment identification tags and components at the locations shown on the Drawings or, if not shown, as directed by ENGINEER; securely mount with concealed theft-resistant fasteners.

B. Install level, plumb, and at the proper height. Repair or replace damaged units as directed by ENGINEER.

END OF SECTION

SECTION 11005

EQUIPMENT: GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Requirement of this Section apply to all equipment provided on the Project, including that found in Divisions 11, 13, 15 and 16, even if not specifically referenced as a related section in those Specifications.

B. Related sections include, but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Section 09800 - Special Coatings.
   3. Section 10400 - Identification, Stenciling and Tagging Systems.
   4. Individual equipment specifications in Divisions 11 through 15.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A307 - Standard Specification Carbon Steel Bolts and Studs, and Threaded Rod 60,000 psi Tensile Strength.
      b. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   2. Institute of Electrical and Electronics Engineers (IEEE):
      a. 112 - Standard Test Procedure for Polyphase Induction Motors and Generators.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6 - Enclosures for Industrial Control and System.
      c. MG1, Motors and Generators.
   4. NSF International:
      a. 61 - Drinking Water System Components

B. Design Codes:
   1. 2018 International Building Codes with Amendments
   2. 2018 International Plumbing Codes with Amendments
   3. 2008 International Fire Code with Amendments
   4. 2017 National Electric Code
   5. 2018 International Mechanical Code
   6. National Fire Protection Association 72

C. Unit Responsibility:

1. Where indicated in these documents, equipment systems made up of two or more components shall be manufactured and assembled as a unit by the responsible manufacturer. The responsible manufacturer shall select all components of the system to assure compatibility, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components, such that all equipment furnished under the specification for the equipment system, including equipment specified elsewhere, but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. This requirement for unit responsibility shall in no way relieve CONTRACTOR of his responsibility to the OWNER for performance of all systems.
2. CONTRACTOR shall assure that all equipment systems provided for the Project are products for which unit responsibility has been accepted by the responsible manufacturer. Where the detailed specification requires CONTRACTOR to furnish a certificate from the Unit Responsibility Manufacturer, such certificates shall be provided prior to Shop Drawing review. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the Work.

1.03 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Equipment: One or more assemblies capable of performing a complete function. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection. Not limited to items listed under "Equipment" article within Specifications.

1.04 SUBMITTALS

A. Shop Drawings:

1. General for all equipment:
   a. See Section 01340.
   b. Acknowledgement that products submitted comply with the requirements of the standards referenced.
   c. Manufacturer's delivery, storage, and handling instructions.
   d. Equipment identification utilizing tagging system and name utilized in Drawings.

e. Equipment installation details:
    1) Location of anchorage.
    2) Type, size, and materials of construction of anchorage.
    3) Anchorage setting templates.
    4) Manufacturer's installation instructions.
f. Equipment area classification rating.
g. Shipping and operating weight.
h. Equipment physical characteristics:
    1) Dimensions (both horizontal and vertical).
    2) Materials of construction and construction details.
i. Equipment factory primer and painting and coating data.
j. Manufacturer's recommended spare parts list.
k. Piping and duct connection size, type and location.

2. Mechanical and Process Equipment
    a. Operating characteristics:
        1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
        2) Brake horsepower requirements.
        3) Copies of equipment data plates.
    b. Piping and duct connection size, type, and location.
    c. Equipment bearing life certification.
    d. Field noise testing reports if such testing is specified in specific equipment sections.
    e. Equipment foundation data:
        1) Equipment center of gravity.
        2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.

3. Electrical and Control Equipment:
    a. Electric motor information:
        1) Nameplate data.
        2) Service factor on motors ½ HP and above.
        3) Motor enclosure type.
        4) NEMA frame size, if applicable.
        5) NEMA design code, if applicable.
        6) Insulation type.
        7) Efficiency and power factor at full load, $^{3}/_{4}$ load, ½ load and $^{1}/_{4}$ load.
    b. Control panels:
        1) Panel construction.
        2) Point-to-point wiring diagrams.
        3) Scaled panel face and subpanel layout.
        4) Technical product data on panel components.
        5) Panel and subpanel dimensions and weights.
        6) Panel access openings.

7) Nameplate test.
8) Panel anchorage.

c. Motor tests reports.

d. Certification that equipment has been installed properly, has been initially started up and is ready for operation.

e. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-make modifications.

B. Operations and Maintenance Manuals:
1. Section 01340.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Motors: US Motors or preapproved equal.

2.02 MANUFACTURED UNITS

A. Electric Motors:
1. Provide motors designed and applied in compliance with NEMA, IEEE, and the NEC for specific duty imposed by driven equipment.
2. Where used in conjunction with adjustable speed drives, provide motors fully compatible with the variable speed controllers. These motors shall be inverter duty.
3. Where frequent starting applications are specified, design for frequent starting duty equivalent to duty service required by driven equipment.
4. Rate for continuous duty at 50 Deg C ambient. Design in accordance with NEMA standards for Class F insulation with Class B temperature rise above 50 Deg C ambient on continuous operation or intermittent duty at nameplate horsepower.
5. Design for full or reduced voltage starting, as appropriate.
6. Design bearing life based upon actual operating load conditions imposed by driven equivalent.
7. Size for altitude of Project.
8. Size so that, under maximum continuous load imposed by driven equipment, motor nameplate horsepower for continuous operation is minimum of 15 percent more than driven load.
9. Provide encapsulated windings in wet/corrosive and for outdoor applications.
a. Provide encapsulation using a silicone or epoxy seal after the windings have been dried to less than 1 percent moisture.

10. Furnish with clamp-type grounding terminals inside motor conduit box.
11. Furnish with oversized external conduit boxes.
12. Furnish with stainless steel nameplates with information to include all data as required by paragraph 430-7 of the National Electric Code, NFPA 70.
13. Totally Enclosed, Fan-Cooled (TEFC) unless specified otherwise.

2.03 ACCESSORIES

A. Guards:
1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
2. Interior Applications:
   a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
   b. Utilize non-flattened type 16 GA galvanized steel with nominal ½ IN spacing.
   c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
3. External Applications:
   a. Construct from 16 GA stainless steel or aluminum.
   b. Construct to preclude entrance of rain, snow, or moisture.
   c. Roll to conform to shaft or coupling surface.
   d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:
1. Cast-in-place anchorage:
   a. Provide ASTM F593, Type 316 stainless steel anchorage for exposed equipment.
   b. For continuously submerged anchorage, utilize ASTM A307 anchorage. For intermittently submerged applications, use 316 stainless steel.
   c. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
   d. Provide two nuts for each bolt.
2. Drilled anchorage:
   a. Epoxy grout per Section 03600.
   b. Threaded rods same as cast-in-place.

C. Data Plate:
1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

2.04 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with best modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Assure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which require periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option. Provide drain connection for tubing.

G. Machine the mounting feet of rotating equipment.

H. Shop or Factory Finishes shall be in accordance with Section 09800.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab mounted equipment.

C. For equipment having drainage requirements such as seal water, provide 3/4-inch PVC or clear plastic tubing from equipment base to nearest floor or equipment drain. Route clear of major traffic areas and as approved by OWNER.

D. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings.

E. Construct subbases, either concrete, steel or cast iron, level in both directions. Particular care shall be taken at hold-down bolt locations so these areas are flat and level.

F. Machine Base:

1. Mount machine bases of rotating equipment on subbases in manner that they are level in both directions according to machined surfaces on base. Use machinist level for this procedure.
2. Level machine bases on subbases and align couplings between driver and driven unit using steel blocks and shims.
   a. Size blocks and shims to provide solid support at each anchor bolt location. Area size of blocks and shims shall be approximately 1-1/2 times area support surface at each anchor bolt point.
   b. Provide blocks and shims at each anchor bolt. Blocks and shims shall be square shape with "U" cut out to allow blocks and shims to be centered on anchor bolts.
   c. After all leveling and alignment has been completed and before grouting, tighten anchor bolts to proper torque value.
   d. Do not use nuts below the machine base on anchor bolts for base leveling.

G. Grouting:

1. After machine base has been shimmed, leveled, couplings aligned and anchor bolts tightened to correct torque value, a dam or formwork shall be placed around base to contain grouting. Dam or formwork shall extend at least ½ inches above the top of leveling shims and blocks.
2. Grouting mixture shall be non-shrink grout per Division 3 requirements.
3. When the grout has sufficiently hardened, remove dam or framework and finish the exposed grout surface to fine, smooth surface. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout. When the grout has fully hardened (after a minimum of 7 days) tighten all anchor bolts and recheck driver-driven unit for proper alignment.

H. Identification of Equipment and Hazard Warning Signs:

1. Identify equipment and install hazard warning signs in accordance with Section 10400.

I. Field coat in accordance with Section 09800.

3.02 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape uninsulated conductors and connectors with electrical tape, 150 percent of insulation value of conductor.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

3.03 FIELD QUALITY CONTROL

A. Furnish equipment manufacturer services as specified in the individual equipment specifications.

B. Inspect wire and connections for physical damage and proper connection.

C. Check rotation of motor before connection to driven equipment, before couplings are bolted or belts installed. Before motor is started to check rotation, determine that motor is lubricated.

END OF SECTION

SECTION 11406

PACKAGED FILTRATION SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. The Supplier shall furnish all three complete Packaged Filtration Systems (PFSs), including all tools, equipment, controls, materials, and accessories. Price shall be inclusive of all equipment, related activities, services, freight, warranty, and support activities, as specified herein and indicated on the drawings. It is the Supplier's responsibility to provide a complete, properly functional, and reliable system which will meet the functional requirements.
   1. The Supplier shall provide skid mounted PFS' to meet the requirements of the Drawings per well site. The PFS' manifold piping and valves location shall be as per the Drawings to allow operator access to valves for operation and maintenance. Any deviation to the Drawings shall be preapproved by the ENGINEER.

B. The PFSs are listed below:
   1. PFS 1 - 100 gallons per minute (gpm) Iron Removal Package 1 (Montezuma Creek Well 1)
   2. PFS 2 - 100 gpm Arsenic Adsorption Package 1 (Montezuma Creek Well 1)
   3. PFS 3 - 55 gpm Arsenic Adsorption Package 2 (Montezuma Creek Well 3)

C. PFS 1 consists of one four ft. diameter filter vessel along with motorized ball valves, flow meters, check valves, differential pressure switch, pressure indicators, and other appurtenances for iron removal as shown on the Drawings. The PFS will operate using manganese dioxide media based filtration for removing iron from the well(s) water.

D. PFS 2 consists of one four ft. diameter filter vessel along with ball valves (motorized and manually operated), flow meters, check valves, differential pressure switch, pressure indicators, and other appurtenances for arsenic removal as shown in the Drawings. The PFS will operate using a granular iron based adsorption media for removing arsenic from the well(s) water.

E. PFS 3 consists of one three ft. diameter filter vessel along with manually operated ball valves, flow meters, check valves, differential pressure switch, pressure indicators, and other appurtenances for arsenic removal as shown in the Drawings. The PFS will operate using a granular iron based adsorption media for removing arsenic from the well(s) water.

F. CONTRACTOR shall install the PFSs. It is the responsibility of the PFS(s) Supplier to coordinate the installation with the CONTRACTOR and the OWNER, and provide detailed installation instructions as part of the shop drawings.

G. These specifications are supplemented by the Drawings. The Supplier shall comply with the requirements of both the Specifications and the Drawings.

1.02 SUMMARY

A. It is the intent of this specification to provide general descriptions and minimum requirements of the major components and accessories of the packaged filtration system(s). It is the Supplier's responsibility to provide a complete, properly functional, and reliable PFS. The Supplier(s), and ultimately the CONTRACTOR, are responsible for the successful operation of the PFS(s)

B. The PFS(s) must interface with various other process instrumentation and equipment not supplied by the PFS vendor. The items not furnished by the PFS vendor include, but are not limited to, are the Backwash Holding Tank, Recycle Pump Station, Sludge Manhole, level sensors, and pressure switches. Refer to P&I diagrams for complete illustration of all interface components.

C. Related Sections include the following (attached to this document):
1. Division 1 - General Requirements
2. Section 01340 - Submittals
3. Section 09800 - Special Coatings
4. Section 13329 - Field Instruments
5. Section 13334 - Magnetic Flowmeter
6. Section 15050 - Basic Piping Materials and Methods
7. Section 15075 - Plastic Piping and Tubing
8. Section 15110 - Valves
9. Section 15111 - Ball Valves
10. Section 15114 - Check Valves

D. The Supplier shall prepare his bid on the basis of the materials and equipment listed herein.

1.03 SUPPLIER PREQUALIFICATION AND PRESUBMITTAL

A. All PFS suppliers (including those named) submitting a bid must be prequalified by the OWNER 14 days in advance of the bid submittal date. The OWNER reserves the sole right to accept or reject the alternate PFS suppliers. As part of the prequalification process, the Supplier(s) shall provide the following information to the OWNER:

1. Scope of supply document to demonstrate compliance with all provisions of the specifications and drawings. This shall include drawings, specifications, and product literature with adequate detail to determine that what is proposed will meet the requirements of the Drawings and Specifications. Information on all control systems, vessel sizes, internals, piping, valves, actuators, and Programmable Logic Controller (PLC) programming shall be provided.
2. PFS 1: A list of three iron or manganese pressure filtration installations between 100 and 700 gpm with plant addresses and telephone numbers. The OWNER may contact these installation sites to determine experience. Any experience that the OWNER has regarding the credibility of the supplier on prior NTUA bids will also be used in evaluating this criteria (whether the supplier lists the project or not). These reference projects shall include steel vessels, maximum hydraulic loading rates of 8 gallons per minute per square foot (gpm/ft^2), electric actuators, PLC controls with operator interface and touch screen panels, and stainless steel underdrain systems. Suppliers with reference installations that use fiberglass vessels, pneumatic actuators, and PVC underdrains will not be considered and will be disqualified.
3. PFS 2 and PFS 3: A list of three arsenic adsorption treatment installations between 100 and 700 gpm with plant addresses and telephone numbers. The OWNER may contact these installation sites to determine experience. Any experience that the OWNER has regarding the credibility of the supplier on prior NTUA bids will also be used in evaluating this criteria (whether the supplier lists the project or not). These reference projects shall include steel vessels, maximum hydraulic loading rates of 8 gallons per minute per square foot (gpm/ft^2), manual valves or electric actuated valves, PLC controls with operator interface and touch screen panels, and stainless steel underdrain systems. Suppliers with reference installations that use fiberglass vessels, pneumatic actuators, and PVC underdrains will not be considered and will be disqualified.
4. Evidence of manufacturing capability including a description of facilities, the number, and professional qualifications of personnel, and quality control practices. The supplier shall identify major outside fabricators for the purpose of determining experience.

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval, in conformance with Section 01340, Submittals, the following:
   1. Letters of Certification of Compliance on materials.
   2. Detail piping arrangement and electrical drawings for all components of the PFS, including pipe supports, flange coupling adapters, valves, appurtenances, and meters, and all electrical conduit layouts and wiring diagrams.

3. Drawings showing fabrication, dimensions, capacity, weight, and materials of construction, electrical diagrams, and installation piping.
4. Dimensional drawings verifying vessel dimensions, wall thickness, mounting details, internals, laterals, header, underdrain piping, interior concrete anchors and vessel anchorage to concrete foundation requirements.
5. General bulletins or catalog cuts showing operating principles and fundamentals.
6. Product Data: List of materials and coatings used.
7. A complete process description detailing all process parameters.
8. Provide structural calculations for vessel and for all support legs, including seismic criteria for supporting elements, as specified in ASME Code.
9. Documentation that the Supplier has produced, supplied and placed into satisfactory service, equipment similar to that specified herein.
10. Recommended list of spare parts and safety equipment, along with price and ordering information.
11. Electrical equipment ratings and data sheets for all devices.
12. Certification and ASME Code data reports in accordance with applicable ASME Code. The certification shall include certification of hydrostatic testing.
13. Detailed installation instructions.

B. No equipment shall be shipped until the ENGINEER approves the Shop Drawings.

C. Shop Test Results: Submit results of factory hydrostatic tests.

D. Field Test Results: Submit a written report giving the results of the required field tests.

E. Supplier's Reports: Submit written report of the results of each visit by a Supplier's serviceman, including purpose and time of visit, tasks performed, and results obtained.

F. Operation and Maintenance Manuals: Submit complete Operation and Maintenance Manuals in conformance with the Operation and Maintenance Manuals Section of Section 01340, Submittals.

1.04 QUALITY ASSURANCE

A. Suppliers regularly engaged in the manufacture of the equipment as specified herein and who can demonstrate equipment of this specified design, in actual service for not less than five years will be considered as acceptable Suppliers. All like items shall be furnished by one Supplier to ensure uniformity and interchangeability of parts. Supplier shall guarantee all equipment furnished.

B. Tests by Independent Regulatory Agencies: Electrical material and equipment shall be new and shall bear the label of the Underwriter's Laboratories, Inc., or other nationally-recognized, independent testing laboratory, wherever standards have been established and label service regularly applies. All power and control wiring, cable, conduit and appurtenances shall meet the requirements of the NEC code.

C. Equipment provided under this section shall be fabricated, assembled, and transported in full conformity with Drawings, Specifications, and engineering data.

D. Components of the filtration vessel shall be the latest standard products of Suppliers regularly engaged in the production of equipment of this type.

E. Provide twenty one days notice to the ENGINEER prior to final assembly and surface preparation of each vessel to allow the ENGINEER to thoroughly inspect the interior and exterior at the fabrication shop.

F. Reference Standards: The Supplier shall ensure that the arsenic treatment system complies with all the latest applicable provisions and recommendations of the societies, associations and institutes referenced throughout these specifications and below, except as otherwise specified.

1. American National Standards Institute.
2. American Society of Mechanical Engineers (coded vessels).
3. American Society for Testing and Materials.
4. American Water Works Association.
5. Factory Mutual Association.
6. Institute of Electrical and Electronics Engineers.
7. National Electrical Manufacturer's Association.
8. National Electrical Code.
9. National Electrical Safety Code.
10. National Fire Protection Association.
11. Instrumentation Society of America.
12. Occupational Safety and Health Act (ladders and hatches on vessels).
13. Underwriters' Laboratories, Inc. (all control and instrument panels shall comply with UL ratings and certifications)
14. Standards of the Hydraulic Institute.
15. NSF International, Standard 61.

G. Codes: All equipment and work shall comply with all local, state, and federal codes, standards, laws, ordinances, and regulations having jurisdiction in the area where the equipment will be installed. Where conflicts exist between the specified standards and the codes, the Supplier shall bring it to the attention of the OWNER. The Supplier shall make necessary tests and inspections to ensure all ordinances, codes and regulations are met.

1.05 PROCESS PARAMETERS

A. The estimated run length of the iron removal filter (PFS 1) is 72 hours, based on a hydraulic loading rate of 6-8 gpm/ft^2. The influent iron level at Montezuma Creek Well 1 is 1.0 mg/L. The influent iron level for the combined water from Montezuma Wells 1 and 2 ranges between 0.3 to 1.0 mg/L.

B. The estimated run length of the arsenic adsorption filter (PFS 2) based on a hydraulic loading rate of 8 gpm/ft^2 and an empty bed contact time (EBCT) of 2 minutes is as follows:
   3. Montezuma Creek Wells 1 and 2: 365 days based on an influent arsenic level of 11-12 pbb, well flow rates of 40-85 gpm and a well utilization rate of 30%.
   4. No pH adjustment is allowed.

C. The estimated run length of the arsenic adsorption filter (PFS 3) based on a hydraulic loading rate of 8 gpm/ft^2 and an EBCT of 2 minutes is as follows:
   1. Montezuma Creek Well 3: 365 days based on an influent arsenic level of 12 ppb, a well flow rate of 53 gpm and a well utilization rate of 30%.
   2. No pH adjustment is allowed.

D. Refer to pilot test results for all water quality data. See Attachment A.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time not to delay that Work.

1.07 WARRANTY

A. The Supplier shall warrant the units being supplied to the OWNER against defects in workmanship and material for a period of one year under normal use, operation, and service. The warranty shall cover parts and labor and shall be in printed form. The warranty shall apply to all similar units.

1.08 SCHEDULE

A. Supplier shall provide complete shop drawings to OWNER within 30 days after notice of award from OWNER. Resubmittals shall be completed within 14 days after receiving comments.

B. PFS vessels and components shall be ready for factory inspection within 12 weeks after approved shop drawings.

C. PFS shall be shipped to the sites within 14 weeks after approved shop drawings.

PART 2 PRODUCTS

2.01 SUPPLIERS

A. PFS 1:
   1. Hungerford and Terry
   2. AdEdge
   3. Wigen Water Technologies
   4. Or approved equal (Alternate Suppliers must be approved prior to the bid date).

B. PFS 2 and PFS 3:
   1. Hungerford and Terry
   2. AdEdge
   3. Wigen Water Technologies
   4. Westech/US Filter.

B. The naming of a Supplier in this Specification is not an indication that the Supplier's standard equipment is acceptable in lieu of the specified component features. Naming is only an indication that the Supplier may have the capability of engineering and supplying a system as specified.

2.02 FILTER VESSELS

A. PSF 1: The PFS shall be equipped with one vessel with the following specifications:
   1. 4'-0" diameter vessel with 6'-0" straight sideshell (not including heads), ends fitted with semi-elliptical heads will be furnished. The filter bed area of each vessel shall be 12.6 sq. ft. The vessel shall be capable of processing a maximum design flow (in treatment mode) of 100 gpm.
   2. When the filter run length of 72 hours (based on pilot testing results) is reached, the filter vessel will be backwashed followed by a rinse. The well(s) will remain offline during backwash and rinse operations. Water from the distribution system will be used for backwash and rinse operations. During this time, the arsenic adsorption vessel (PFS 2) shall remain offline (i.e., no water will be sent through PFS 2). The vessel will be backwashed at a flow rate of 150 gpm (hydraulic loading rate (HLR) of 12 gpm/ft^2) for a 10 minute duration. Once backwashing is completed, the vessels will be rinsed using distribution system water of 100 gpm (HLR of 8 gpm/ft^2) for a 3 minute duration. Once the rinse mode is completed, the vessel will be brought back online.

B. PFS 2: The PFS shall be equipped with one vessel with the following specifications:

1. 4'-0" diameter vessel with 6'-0" straight sideshell (not including heads), ends fitted with semi-elliptical heads will be furnished. The filter bed area of each vessel shall be 12.6 sq. ft. The vessel shall be capable of processing a maximum design flow (in treatment mode) of 100 gpm.
2. When the filter run length of approximately 365 days (based on pilot testing results) is reached, the adsorption vessel will be backwashed followed by a rinse. The well(s) will remain offline during backwash and rinse operations. Water from the distribution system will be used for backwash and rinse operations. During this time, the filter vessel (PFS 1) shall remain offline (i.e., no water will be sent through PFS 1). The vessel will be backwashed at a flow rate of 150 gpm (HLR of 12 gpm/ft^2) for a 10 minute duration. Once backwashing is completed, the vessels will be rinsed using distribution system water of 100 gpm (HLR of 8 gpm/ft^2) for a 3 minute duration. Once the rinse mode is completed, the vessel will be brought back online.

C. PFS 3: The PFS shall be equipped with one vessel with the following specifications:

1. 3'-0" diameter vessel with 6'-0" straight sideshell (not including heads), ends fitted with semi-elliptical heads will be furnished. The filter bed area of each vessel shall be 7.1 sq. ft. Each vessel shall be capable of processing a maximum design flow (in treatment mode) of 56 gpm.
2. When the filter run length of approximately 365 days (based on pilot testing results) is reached, the adsorption vessel will be backwashed followed by a rinse. The well(s) will remain offline during backwash and rinse operations. Water from the distribution system will be used for backwash and rinse operations. During this time, the arsenic adsorption vessel (PFS 1) shall remain offline (i.e., no water will be sent through PFS 1). The vessel will be backwashed at a flow rate of 85 gpm (HLR of 12 gpm/ft^2) for a 10 minute duration. Once backwashing is completed, the vessels will be rinsed using distribution system water of 56 gpm (HLR of 8 gpm/ft^2) for a 3 minute duration. Once the rinse mode is completed, the vessel will be brought back online.

D. All the vessels shall be rated for a pressure of 125 psig. The vessels shall be constructed in accordance with ASME code requirements with ASME code stamp required.

C. Each vessel shall be equipped with necessary flanges and connections for the main piping system, as shown on the Drawings. One 18-inch diameter access manway with a hinged cover on top of the vessel shall be provided for access to each vessel and for loading media into the vessel.

D. The vessels shall be supported on structural steel legs properly spaced (and cross braced as needed) as shown in the Drawings.

2.03 FLAT BOTTOM SUPPORT

A. All the vessels shall be equipped with a flat bottom support to provide a level base from which to construct the vessel from. The flat bottom shall be constructed with steel plates with structural supports. The system shall be designed such that water does not come into contact with the uncoated portions of the vessels and structural sections beneath the flat plate.

2.04 HEADER AND UNDERDRAINS

A. Header piping and all structural supports and hardware for header piping shall be Schedule 40 304 SS pipe. The orifices in the header shall be sized for 1 psi headloss at the design backwash rate.

B. The following configurations are acceptable for underdrain piping:
   1. 304 SS Schedule 40 pipe with orifices wrapped in wedgewire (Johnson screens or similar). All structural supports and hardware for underdrain piping shall be Schedule 40 304 SS pipe.
   2. The maximum headloss through the underdrain system shall be 1-2 psi during backwashing under either configuration.

2.05 SUPPORT MEDIA

A. Refer to Section 13221 for details.

2.06 IRON REMOVAL MEDIA

A. Acceptable Manufacturers:
   1. Safe Water Technologies - MetalEase-61
   2. No approved equals.

B. Material Specifications:
   1. Physical Parameters:
      a. Moisture content (maximum) 46-50% (upon arrival at site).
      b. Unit weight (bulk density): 114 lbs/ft^3 (5% tolerance)
      c. Gradation:
         (1) 12 x 40 mesh (nominal size, wet)
         (2) Engineer will perform testing upon arrival of filtration media shipment to assess compliance with specifications.
      d. Color: Grey - black
      e. Odor: None

f. Form: Granular
g. Specific gravity 5.0
h. Backwash rate: 12 gpm/ft^2
i. Loading rate: 8 gpm/ft^2
j. Bed Depth - 2 ft

2. Media Chemical Composition
   a. Manganese dioxide content: 75-85%
   b. Manganese content: 45-55%

C. Media shall be NSF/ANSI Standard 61 certified.

D. Media shall meet the requirements of AWWA B100, latest revision, including provisions for skimming. Media shall be shipped bagged and palletized.

2.07 ARSENIC ADSORPTION MEDIA

A. Acceptable Manufacturers:
   1. Bayoxide E-33
   2. Evoqua (formerly Siemens) Granular Ferric Hydroxide (GFH).
   3. Media Specifications:
      a. Empty bed contact time (EBCT): 2 minutes
      b. Loading rate: 8 gpm/ft^2
      c. Backwash rate: 12 gpm/ft^2
      d. Bed Depth - 2 ft

B. Media shall be NSF/ANSI Standard 61 certified.

C. Media shall be shipped bagged and palletized.

2.08 INFLUENT DISTRIBUTION AND WASH WATER COLLECTION

A. The method of introduction of raw water to the vessel(s) or the collection of wash water from the unit(s), shall be such that water is distributed to, or collected from, the entire media bed in a uniform manner.

B. The distribution and collection system of the vessel shall be arranged to accommodate backwashing at the rate of 12.0 gallons per minute per square foot of media surface.

C. The arrangement of the collection systems shall provide for the proper backwashing of the media beds without loss of filtering material. The distance from the surface of the bed to the wash water collector (freeboard) shall be not less than 50% of the depth of the media bed.

2.09 PIPING, VALVES, ACTUATORS AND FLOWMETERS

A. The vessel piping shall be arranged to carry out the following operations:
   1. Filtering.
   2. Backwashing each vessel with distribution system water.
   3. Rinsing each vessel with distribution system water.

B. The piping arrangement shown on the drawings requires ball valves (manually operated and motor operated valves (MOVs), and check valves, as shown on the Drawings, collectively called the vessel manifold valves. The piping arrangement also includes flow meters, as shown on the Drawings. These valves and flow meters shall also be part of the PFS.

C. PFS pipe sizing shall be as indicated on the Drawings and Specifications. Information such as coatings, fabrication standards, connections and method of assembly and interface with valves and meters must be provided for consideration.

D. The filter manifold valves shall be ball valves and shall meet the requirements of the Section 15111.

E. Flowmeters shall be meet the requirements of Section 13334. The transmitters to the flowmeters will be mounted integral to the device.

F. All necessary air vents and relief valves shall be furnished along with drain piping.

I. All nuts, bolts, washers, and vessel support anchor bolts that are needed for a proper installation shall be furnished by the Supplier. Provide SS hardware as shown on the Drawings.

2.10 LOSS OF HEAD GAUGES

A. The vessels shall be equipped with a pressure gauge assembly to indicate loss of head. The assembly shall consist of two pressure gauges mounted on an aluminum nameplate mounting bracket and installed on the inlet and outlet header piping of each vessel. Pressure gauges shall meet the requirement of Section 13329.

2.11 DIFFERENTIAL PRESSURE SWITCH

A. Each vessel shall be equipped with a differential pressure switch (DPS 1, DPS 2 and DPS 3, respectively), adjustable from 0-50 psi. When the set point is reached, it will inform the PLC to initiate a filter backwash. Differential pressure switches shall meet the requirement of Section 13329.

2.12 FULLY AUTOMATIC CONTROL

A. General:

1. A control system shall be furnished to provide fully automatic control of the vessels. The PLC will be Allen Bradley Micrologix. The control system shall interface with all instruments associated with the PFS and others that may not be supplied by the PFS vendor (as referenced in Paragraph 1.02 B of this Section). The PLC will also transmit all signals from the PFS and the other components to the OWNER's Supervisory Control and Data Acquisition (SCADA) system via radio frequency.

B. The PFS supplier shall provide a Control logic and programming description for review by the ENGINEER during shop drawing review phase prior to supplying the PLC and Automatic Control System.

C. Control Logic:

1. The PFS PLC, called as WTF PLC herein, will function as the master PLC for the entire treatment facility. The WTF PLC will control the operation of the PFS and interface with other equipment part of the WTF as listed below:
   a. Motor operated valves
   b. Flow meters
   c. Field instruments (level transmitters, level switches, pressure switches, pressure transmitters, pump station, etc.)
2. Depending on the well site location where the PFS is installed, the flow through the PFS will vary. The entire well flow will be treated by the PFS. During backwash mode, the vessel will be backwashed using distribution system water. The backwash flow rate will be 150 gpm through the vessel (for PFS 1 and 2) and 85 gpm through the vessel (for PFS 3). After backwashing, the vessels will be rinsed at a flow rate of 100 gpm (for PFS 1 and PFS 2) and 55 gpm for PFS 3.
3. When the WTF PLC receives a "Call to Run" command for the well(s), the WTF PLC checks the mode of operation and if the valves are in the right position for the mode of operation. If all the valves are in the correct position, the WTF PLC sends a permissive signal indicating that all components of the PFS and related equipment are functional, valves are in the correct operating position, and no alarm conditions exist. If the PFS and related components are not ready to process water, the permissive signal will not be returned, indicating a fault with the PFS or related equipment.
4. When the well permissive signal is received, SCADA starts the well(s). The flow rate set point is operator adjustable from the WTF PLC. The flow rate set point will be as follows:
   a. Normal Operation Mode: 100 gpm (PFS 1 and 2), 55 gpm (PFS 3).
   b. Backwash Mode: 150 gpm (PFS 1 and 2), 85 gpm (PFS 3).

c. Rinse Mode: 100 gpm (PFS 1 and 2), 55 gpm (PFS 3).

5. An emergency bypass valve is also provided which can be manually operated in the event of an emergency. This will allow the well to bypass the treatment system (PFS1, PFS2, PFS 3) temporarily until the treatment system is ready to be placed in operation.
6. PFS 1 is fully automated to allow operation in treatment, backwash and rinse modes to be controlled by the WTF PLC. The PLC will shut down the well in the event of alarm conditions or equipment failure.
7. PFS 2 is partially automated to allow only treatment mode to be controlled by the WTF PLC. Backwash and rinse modes will be manually performed by an operator by manually changing the positions of the valves for those particular modes. The PLC will shut down the well in the event of alarm conditions or equipment failure.
8. PFS 3 is partially automated to allow the well to start/stop by the ATF PLC. All the valves are manually operated ball valves and will be adjusted manually by an operator for treatment mode. An operator will manually shut down the well from the WTF PLC to initiate a backwash or rinse operation.
9. The PFS and other components of the system shall continue to operate until the "Call to run" for the well is stopped, or until backwashing is initiated (automatically or manually), or if an alarm condition occurs.
    a. When the well stops and the flow through the WTF approaches zero, all components of the WTF shall be turned off and the units shall return to an idle mode.
10. The WTF PLC indicates vessel failure alarm for too frequent backwashing (for PFS 1 only) and shuts down PFS 1 and PFS 2 and the well.

D. The PFS system essentially operates in three modes - filtration, backwash and rinse. During filtration mode, the water is passed in downflow mode through the PFS' for removal of iron and/or arsenic; the treated water is then sent to distribution system. The distribution system water is used for backwashing and rinsing the PFS vessels. The backwash and rinse effluent from the PFS' is sent to two backwash holding tanks. The decant from the backwash holding tanks is recycled to the PFS influent by a recycle pump station, consisting of two pumps (one in operation, one in standby). The 1% solids from the bottom of the backwash holding tanks are sent to a sludge manhole and pumped to an off-site location periodically.

2.13 OIT SCREENS

A. The OIT is the interface between the WTF PLC and the entire facility. The Supplier shall provide the following screens on the OIT.

1. Overview Screen: It is the main menu screen that will allow the operator access to the status and control of the entire WTF. The

overview screen shall include a basic schematic (line diagram of the entire WTF process), indicate the operational mode, display the totalized flow treated by each vessel in gallons, and provide a link to the other screens. The overview screen will allow the operator to shut down the treatment facility. The overview screen shall provide a link to the following screens:

2. Valves Screen
3. Vessels Screen
4. Alarms Summary Screen.
5. Recycle Pump Station Screen
6. Backwash/Rinse Screen
7. Tank Level Indicators Screen.
8. System Setpoints

B. The Supplier shall provide screenshots of the mock screens during shop drawing submittals.

2.14 CONTROL PANEL

A. The control panel shall UL rated and be a NEMA 4X standing control cabinet. The panel shall also include a Allen Bradley Micrologix programmable logic controller (PLC) with Allen Bradley HMI interface, a non-volatile memory module, and relays all shop wired to a marked terminal strip and tested before shipment. All relays shall be of the plug in type for easy servicing. Mounted on the front of the control panel shall be the Easy Touch Panel Operator Interface Terminal (OIT). Provide 15" diagonal screen OIT (Hope Industries or Equal). Provide Easy Touch Panel that is programmable with any HMI that runs on Windows XP. Provide Easy Touch Panel EZ-15MT that can communicate to the PLC using Modbus Ethernet driver or equal.

B. Provide hinged lockable door handles for closing the Panel (multiple bolts with fasteners will not be acceptable).

C. The Supplier shall provide the necessary equipment to provide an interface between the WTF PLC and SCADA.

D. The Personal Computer shall be capable of storing data and have trending capabilities.

E. All wire inserts shall be lock in place type. Keyed tongue wire connections are not acceptable.

2.15 PROGRAMMING SERVICES

A. The Supplier shall provide all necessary programming of the WTF PLC and OIT using the latest version of applicable Allen Bradley software. All

software licensing costs shall be provided by the PFS supplier. The services shall include development of informational screens for status and control of equipment, adjustment of process set-points, and alarm displays as discussed in the prior sections, loading of the software to the WTF PLC, interfacing with equipment controlled by the WTF PLC, assisting with start-up of the facility, and troubleshooting the software once the facility is operating to ensure desired controls are functional. Included shall be 2 - 40 hour trips plus one 16 hour trip for the facility (3 trips total for facility). Support services shall also include an additional 24 hours of programming changes to accommodate in-field adjustments during startup.

B. The programming shall include the following in addition to the controls discussed in Section 2.12:
   1. Equipment startup sequence for the various operating modes.
   2. Valve opening sequence and time delay during opening/closing valves for the various operating modes and during transition of operating modes.
   3. Time delays for various alarm conditions.
   4. Description of alarms that do/do not shut down the well.

C. The programmer shall be responsible for providing warranty and troubleshooting support for the system for a one-year period following the date of substantial completion. In addition to the work provided above, the programmer shall provide the following:
   1. Mockup of screens for ENGINEER review prior to loading software at the project site.
   2. After programming is finalized and checked out in the field, two copies of the programming are to be provided on CD to OWNER.
   3. Provide one copy of final screens to ENGINEER for use in preparing the project Operation and Maintenance Manual.
   4. Prior to programming activities, the programmer shall participate in a meeting with the OWNER and ENGINEER to discuss the programming approach and ensure understanding of the scope of work.
   5. The Supplier shall provide warranty programming for the WTF PLC. To provide the warranty programming, the Supplier shall retain an experienced programmer that is physically located within 400 miles of Montezuma Creek, who shall be available on-site within 48 hours after being called to address programming issues. The warranty programming shall include 3 site visits; each visit shall include a minimum of 8 hours of on-site programming work.

2.15 SAMPLING COCKS

A. Sampling cocks shall be provided so that representative water samples may be secured at the following points:
   1. Vessel Influent and Effluent Lines (for each vessel).

2. Combined Treated Water Effluent Line.
4. Backwash Effluent Line.

2.16 COATING

A. See Section 09800. The exterior shall be shop primed and the interior shall be shop primed and shop coated per Specifications.

2.17 RELIEF VALVES

A. Pressure Relief: The vessel shall be equipped with a pressure relief valve to evacuate water (partial flow) in the case of an emergency (1½" x 2½"). Valve shall have bronze bonnet and base, stainless steel disc, and packed cap. Valves shall be set to relieve pressure at the working pressure of the vessel (i.e., 90 psi).

B. Air/Vac Valves: The vessel shall be equipped with an air/vac valve. Provide soft rubber seat for air/vac valves (seat at 5 psi).

2.18 SPARE PARTS

A. Provide following spare parts: One valve and electric actuator assembly, one OIT, one set of I/O modules, relays (if used), controls and fuses.

PART 3 EXECUTION

3.01 INSTALLATION

A. Supplier shall work with the CONTRACTOR to ensure that the PFS is installed in accordance with the Supplier's recommendations.

B. All equipment shall be operationally tested by the Supplier in conjunction with the CONTRACTOR at the job site following installation of the equipment, controls, valves, and piping. Tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent, continuous operation.

3.02 SUPPLIER'S FIELD SERVICE

A. A factory trained representative of the Supplier shall be provided for installation supervision, start-up and test services, and operation and maintenance personnel training services as specified in Section 01650. The factory representative shall provide services as described in Section 2.15.

B. All costs, including travel, lodging, meals, and incidentals, shall be considered as included in the Supplier's price.

C. Up to 24 hours of programming modifications shall be included per site in the base bid.

END OF SECTION

Attachment A

PILOT TESTING RESULTS SUMMARY

Table 3.2 : Montezuma Creek Wells Water Quality

Parameters	Units	MW1	MW1	MW2	MW2	MW3	MW3
Date		05/18/16	11/23/16	05/18/16	11/23/16	05/18/16	11/23/16
pH (Field)	Std Unit	8.42	8.7	8.18	8.6	8.43	8.9
Temperature (Field)	^{o}C	16.9	17.0	19.2	17.0	18.0	15.0
Conductivity (Field)	µS	2,510	-	1,077	-	1,744	-
Arsenic (Lab)	ppb	14	12.4	7.9	9.3	13.7	10.1
Iron (Lab)	mg/L	1.32	0.45	0.06	0.13	0.23	0.13

Table 3.3 summarizes last one year arsenic data provided by NTUA for Montezuma Creek wells. It shows that MW1 arsenic levels ranged from 5 to 14.9 ppb; MW2 arsenic levels ranged from 4.4 to 14.3 ppb; and MW3 arsenic levels ranged from 7.6 to 13.9 ppb. The data shows that all the three wells have had arsenic levels above the primary MCL.

Table 3.3 : Historical Arsenic Data for Montezuma Creek Wells

Date	Units	MW1	MW2	MW3
02/05/15	ppb	14.6		
02/17/15	ppb		13	
05/05/15	ppb	5	4.4	8.3
05/12/15	ppb			9.2
11/03/15	ppb	14.9	14.3	13.9
11/20/15	ppb		8.5	
03/15/16	ppb		6.3	7.6

4.0 PILOT TESTING

The pilot testing was conducted at AW3 and MW1 well sites as per the Pilot Testing Protocol dated May 2016. At each location, two pilot treatment trains - coagulation/filtration (Train 1 or TR1) and oxidation/filtration/adsorption (Train 2 or TR2) were assembled. After the initial shake down period, the pilot testing began. The pilot testing was conducted from August 9 to October 7, 2016.

The pilot units were monitored for the entire period of testing by visiting the site twice every week. Samples were collected for their analysis for field (iron, arsenic, pH, temperature, chlorine and turbidity) and laboratory analysis (iron, arsenic, alkalinity, calcium, magnesium, silica, manganese, vanadium, fluoride, sulfate, and phosphate). In addition, flow through the units and headloss were monitored for each column throughout the pilot study period. Appendix A presents Aneth and Montezuma Creek pilot testing laboratory data. Appendix B presents Aneth pilot testing field data. Appendix C presents Montezuma Creek pilot testing field data. The pilot testing results are discussed in the following sections.

4.1 Aneth Pilot Testing Data

During pilot testing, well water was supplied to the pilot unit from a hose bib located downstream of the chlorine injection point. Train 2 pilot unit treated the well water 24x7. It is important to note that if AW3 was not running at any given time, pilot unit was receiving water from the distribution system during that period of time. Distribution water is a blend of all the three Aneth wells. For this report, pilot unit inlet water stream is referred as "Raw Water".

Table 4.1 presents raw water quality observed during the pilot testing. Raw water arsenic ranged form 8.7 to 11.7 ppb with an average of 10.9 ppb. Raw water is moderately hard with elevated alkalinity values. Raw water iron ranged from 0.34 to 0.52 mg/L with an average of 0.45 mg/L. Silica can compete with arsenic on adsorption media and was analyzed at 9.3 mg/L. Vanadium is another water constituent that can compete for adsorption sites but was below the detection limit (reported at 17.5 ppb which is half of the detection limit of 35 ppb).

Table 4.1 : Aneth Raw Water Quality during Pilot Testing

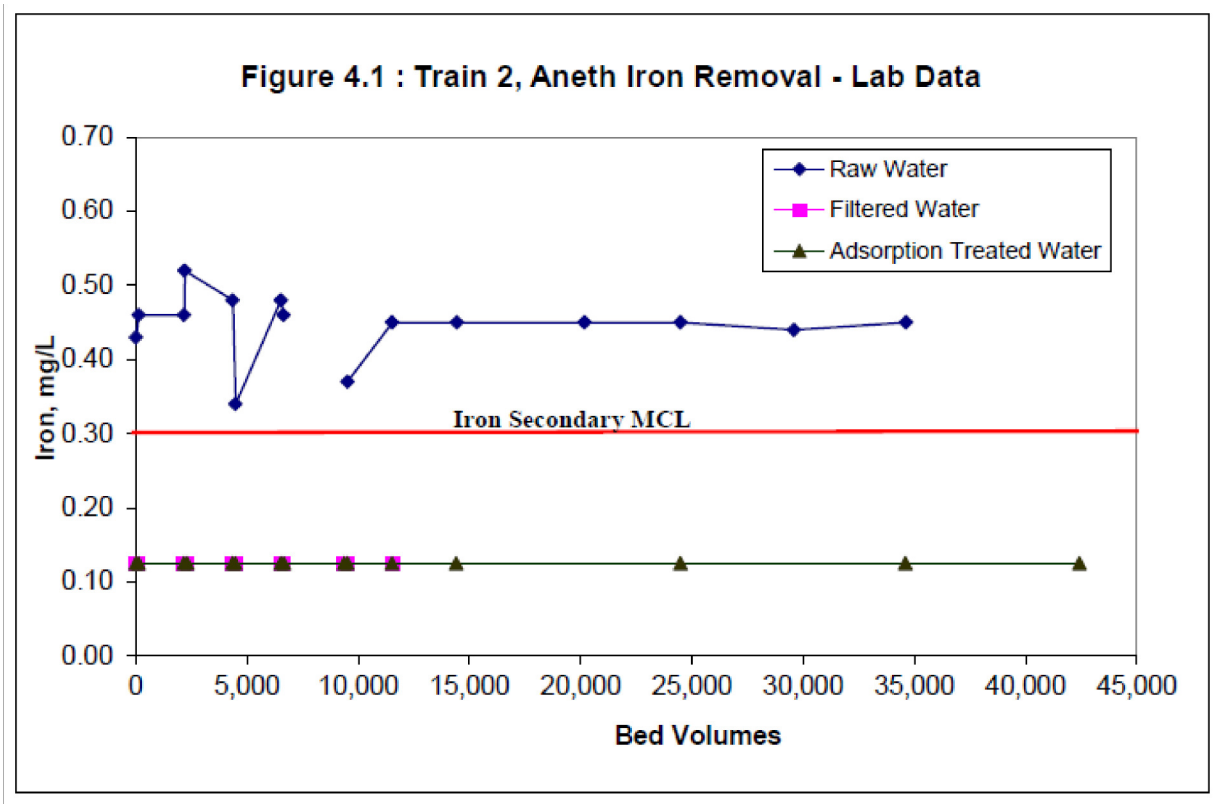
Parameter	Units	Range	Average
Arsenic	ppb	8.7 - 11.7	10.9
Calcium	mg/L	34 - 37	35
Fluoride	mg/L	0.38 - 0.48	0.42
Iron	mg/L	0.34 - 0.52	0.45
Magnesium	mg/L	18 - 19	18.9
Manganese	mg/L	0.05 - 0.22	0.071
pH (Field)	Std. Unit	7.6 - 8.5	8.2
Silica, Total	mg/L	8.9 - 9.5	9.3
Sulfate	mg/L	45.6	45.6
Temperature (Field)	^{o}C	19 - 22.5	20.9
Total Alkalinity as $CaCO_3$	mg/L	374 - 423	409
Total Phosphorous	mg/L	25	25
Turbidity (Field)	NTU	0.24 - 1.54	0.57
Vanadium	ppb	17.5	17.5

4.1.1 Oxidation-Filtration-Adsorption System Pilot Testing Results

Train 2 (Oxidation-Filtration-Adsorption) pilot testing began on August 9, 2016. The objective of the pilot train was to evaluate removal of iron and arsenic by the Metalease (a catalytic media) and Bayoxide E-33 adsorption media. NTUA added chlorine during the normal operations and additional chlorine for oxidation of iron was not added. Operational records obtained from NTUA indicated that approximately 0.30 mg/L of chlorine was added to the well water.

Iron Removal: Overall, 16 pilot runs using the Metalease media were conducted. The pilot runs ranged from 72 hours to 96 hours and filtration unit was operated at 10 gallons per minute per square foot (gpm/ft^2) loading rate. As shown on Figure 4.1, the Metalease media removed iron from the raw to below the detection limit of 0.25 mg/L (breakthrough shows half of iron detection limit). The

pressure loss developed during filtration ranged from 4 to 12 psi. At the conclusion of each pilot run, filter was backwashed at approximately 12 gpm/ft^2. Iron in the adsorption column effluent was below the detection limit as it was completely removed by the Metalease media.



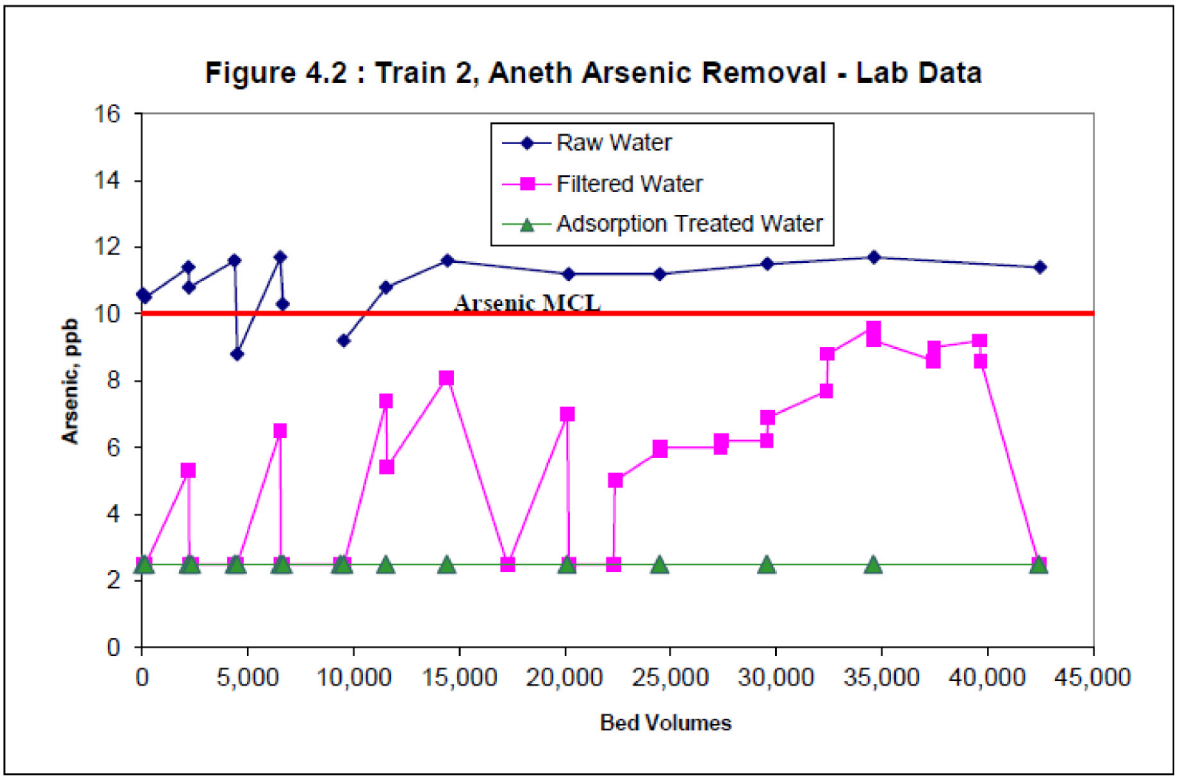
Raw and filtered water iron levels were analyzed in the field at the beginning and end of cycle. Table 4.2 presents field iron data for raw and filtered water samples. Similar to lab data, field data shows complete removal of raw water iron through the metalease filter. Raw water iron level was measured in the range of 0 to 0.62 mg/L with an average of 0.44 mg/L. And the filtered water iron level was measured in the range of 0 to 0.27 mg/L with an average of 0.09 mg/L.

Arsenic Removal: Figure 4.2 shows arsenic removal via Metalease filter and the adsorption media. Arsenic was removed by the Metalease media and the media was reactivated during backwash. The Metalease media removed arsenic to below 8 ppb (with 20% safety factor for arsenic MCL of 10 ppb) for the first six pilot runs but the behavior of the next 10 runs was different.

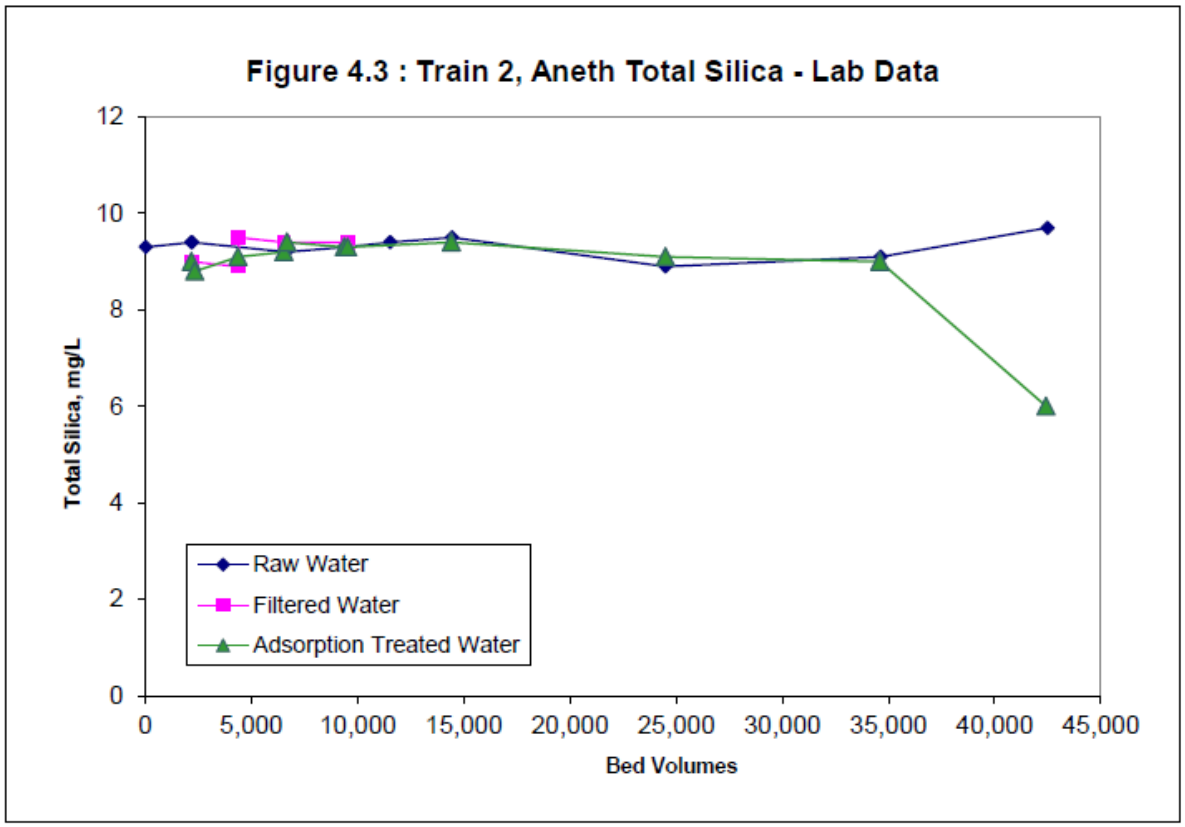
As shown on Figure 4.2, the E-33 adsorption media (with an EBCT of 1.5 minutes) reduced the filtered water arsenic level to below detection limit (5 ppb) for up to 42,500 bed volumes (BVs, volume of water treated per volume of bed). The arsenic breakthrough (arsenic level above detection limit) was not observed during the pilot testing period.

Table 4.2 : Aneth Field Iron Data

Run #	Raw Water			Filtered Water		
	Date	Hour	Iron, mg/L	Date	Hour	Iron, mg/L
Run 1	08/09/16	30 minute	0.46	08/09/16	30 minute	0.06
	08/09/16	4 Hr	0.49	08/09/16	4 Hr	0
	08/12/16	72 Hr	0.5	08/12/16	72 Hr	0.16
Run 2	08/12/16		0.5	08/12/16	30 minute	0.04
				08/12/16	4 Hr	0.07
				08/15/16	72 Hr	0.07
Run 3				08/15/16	30 minute	
	08/15/16	4 Hr	0	08/15/16	4 Hr	0.07
	08/18/16	72 Hr	0.54	08/18/16	72 Hr	0.27
Run 4				08/18/16	30 minute	0.11
	08/18/16	4 Hr	0.51	08/18/16	4 Hr	0.1
	08/22/16	72 Hr	0.12	08/22/16	72 Hr	0.05
Run 5				08/22/16	30 minute	0.05
	08/22/16	4 Hr	0.4	08/22/16	4 Hr	0.04
	08/25/16	72 Hr	0.48	08/25/16	72 Hr	0.04
Run 6	08/25/16	30 minute	0.48	08/25/16	30 minute	0.09
	08/29/16	96 Hr	0.45	08/29/16	96 Hr	0.02
Run 7	08/29/16	30 minute	0.47	08/29/16	30 minute	0.05
	09/02/16	96 Hr	0.46	09/02/16	96 Hr	0.07
Run 8	09/02/16	30 minute	0.46	09/02/16	30 minute	0.05
	09/06/16	96 Hr	0.62	09/06/16	96 Hr	0.24
Run 9	09/06/16	30 minute	0.46	09/06/16	30 minute	0.07
	09/09/16	72 Hr	0.52	09/09/16	72 Hr	0.18
Run 10	09/09/16	30 minute	0.5	09/09/16	30 minute	
	09/12/16	72 Hr	0.46	09/12/16	72 Hr	0.11
Run 11	09/12/16	30 minute	0.07	09/12/16	30 minute	0.06
	09/16/16	96 Hr	0.49	09/16/16	96 Hr	0.1
Run 12	09/16/16	30 minute	0.5	09/16/16	30 minute	0.07
	09/19/16	72 Hr	0.47	09/19/16	72 Hr	0.09
Run 13	09/19/16	30 minute	0.45	09/19/16	30 minute	0.14
	09/23/16	96 Hr	0.49	09/23/16	96 Hr	0.14
Run 14	09/23/16	30 minute	0.47	09/23/16	30 minute	0.05
	09/26/16	72 Hr	0.45	09/26/16	72 Hr	0.09
Run 15	09/26/16	30 minute	0.45	09/26/16	30 minute	0.23
	09/30/16	96 Hr	0.45	09/30/16	96 Hr	0.12
Run 16	09/30/16	30 minute	0.48	09/30/16	30 minute	0.08
	10/03/16	72 Hr	0.44	10/03/16	72 Hr	0.1
		Minimum =	0.00		Minimum =	0.00
		Maximum =	0.62		Maximum =	0.27
		Average =	0.44		Average =	0.09



Impact on Arsenic Removal due to Silica: Figure 4.3 shows the silica breakthrough through the Metalease and E-33 media. Both media result in a minor reduction of silica and the media were saturated with silica at around 10,000 BVs. Based on the raw water silica level and non-breakthrough of arsenic from E-33 column, it appears that silica does not appear to impact the arsenic removal by E33 media.



A pilot study using E-33 media at Santa Fe, NM, was projected to treat 110,000 BVs with an influent arsenic level ranging between 17.8 to 19.6 ppb. A second study using the E-33 media at Weatherford, OK, was projected to treat 73,100 BVs with an influent arsenic level ranging from 15.7 to 30 ppb.

Based on the well water arsenic levels at AW2 and AW3, and reduced arsenic levels after the Metalease filter, the project bed volumes treated at Aneth would be at a minimum of 85,000 BVs.

Impact on Other Water Quality Parameters: Tables 4.3 and 4.4 present water quality observed for Filtered and Adsorption treated water during the pilot testing. It shows that other than arsenic, iron, manganese, and turbidity, all other water quality parameters (including calcium, fluoride, magnesium, pH, alkalinity) were not affected by the treatment process.

Table 4.3 : Aneth Filtered Water Quality during Pilot Testing

Parameter	Units	Range	Average
Arsenic	ppb	2.5 - 9.6	5.2
Calcium	mg/L	34 - 37	35
Fluoride	mg/L	0.39 - 0.42	0.41
Iron	mg/L	ND	ND
Magnesium	mg/L	18 - 19	18.6
Manganese	mg/L	0.05	0.050
pH (Field)	Std. Unit	7.6 - 8.5	8.1
Silica, Total	mg/L	8.9 - 9.5	9.2
Temperature (Field)	^{o}C	18 - 22	20.7
Total Alkalinity as $CaCO_3$	mg/L	422 - 424	423
Turbidity (Field)	NTU	0.16 - 0.74	0.34
Vanadium	ppb	17.5	17.5

ND means Non Detect.

Table 4.4 : Aneth Adsorption Treated Water Quality during Pilot Testing

Parameter	Units	Range	Average
Arsenic	ppb	2.5	2.5
Calcium	mg/L	32 - 37	35
Fluoride	mg/L	0.39 - 0.46	0.41
Iron	mg/L	ND	ND
Magnesium	mg/L	17 - 19	18.6
Manganese	mg/L	0.05	0.050
pH (Field)	Std. Unit	7.7 - 8.3	8.0
Silica, Total	mg/L	6 - 9.4	8.9
Temperature (Field)	^{o}C	20 - 23	21
Total Alkalinity as $CaCO_3$	mg/L	394 - 423	412
Total Phosphorous	mg/L	25	25
Turbidity (Field)	NTU	0.15 - 0.45	0.25
Vanadium	ppb	17.5	17.5

ND means Non Detect.

4.2 Montezuma Creek Pilot Testing Data

Similar to Aneth pilot testing, at Montezuma Creek MW1 site, the well water was supplied to the pilot unit from a hose bib located downstream of the chlorine injection point. Train 2 pilot unit treated the well water 24x7. It is important to note that if MW1 or MW2 well was not running at any given time, pilot unit was receiving water from the distribution system during that period of time. Distribution water is a blend of all the three Montezuma Creek wells. For this report, pilot unit inlet water stream is referred as “Raw Water”.

Table 4.5 presents raw water quality observed during the pilot testing. Raw water arsenic ranged form 7.9 to 11.3 ppb with an average of 9.8 ppb. Raw water is moderately hard with elevated alkalinity values. Iron ranged from non detect (ND) to 0.42 mg/L (one data point). Silica can compete with arsenic on adsorption media and was analyzed at 9.1 mg/L. Vanadium is another water constituent that can compete for adsorption sites but was below the detection limit. Compared to Aneth, the Montezuma Creek groundwater appears to have high sulfate and probably high total dissolved solids.

Other than iron, no significant impact on arsenic treatment is anticipated from other water quality parameters.

Table 4.5 : MC Raw Water Quality During Pilot Testing

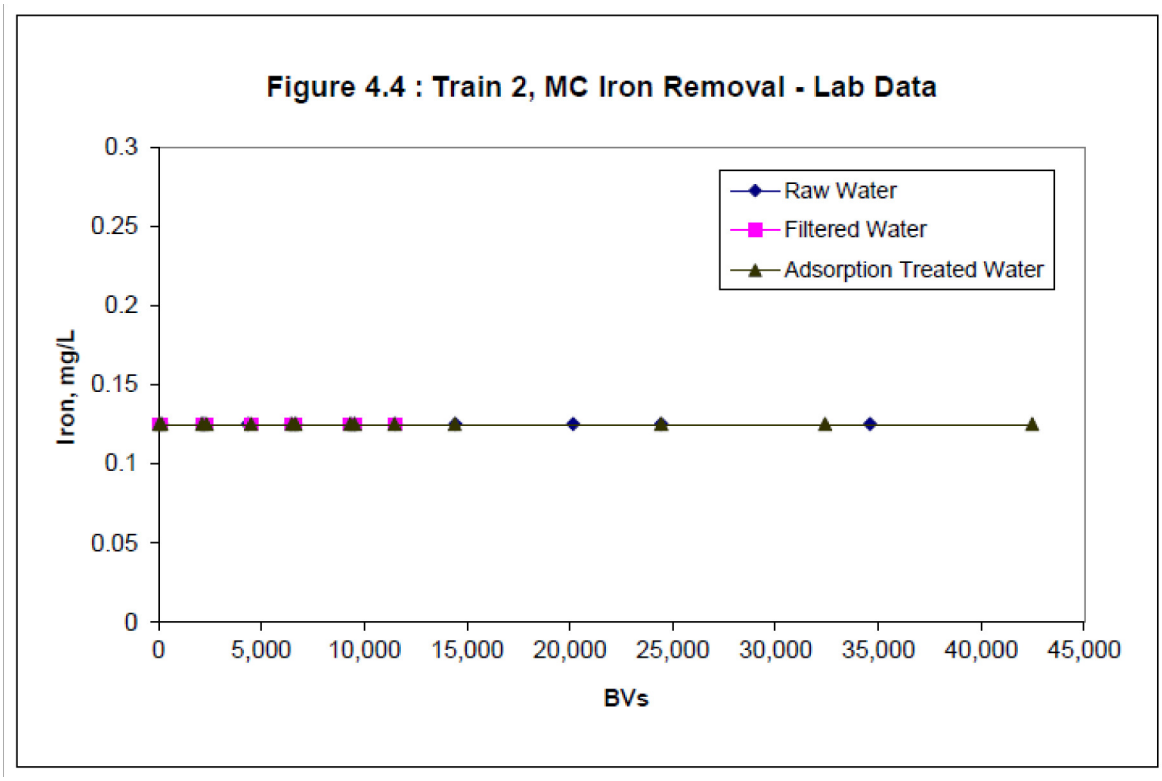
Parameter	Units	Range	Average
Arsenic	ppb	7.9 - 11.3	9.8
Calcium	mg/L	24 - 35	31
Fluoride	mg/L	0.89 - 1.06	1.0
Iron	mg/L	ND - 0.42	ND
Magnesium	mg/L	11 - 22	18
Manganese	mg/L	0.05	0.05
pH (Field)	Std. Unit	7.6 - 8.9	8.4
Silica, Total	mg/L	8.6 - 9.9	9.1
Sulfate	mg/L	258	258
Temperature (Field)	^{o}C	16 - 23	19.2
Total Alkalinity as $CaCO_3$	mg/L	379 - 466	427
Total Phosphorous	mg/L	25 - 80	39
Turbidity (Field)	NTU	0.27 - 1.89	0.65
Vanadium	ppb	17.5	17.5

ND means Non Detect.

4.2.1 Oxidation-Filtration-Adsorption System Pilot Testing Results

Train 2 (Oxidation-Filtration-Adsorption) pilot testing was conducted from August 4 to November 3, 2016. Similar to Aneth, the objective of the pilot train was to evaluate removal of iron and arsenic by the Metalease and Bayoxide E33 adsorption media, and to develop design criteria for the treatment facility. NTUA added chlorine during the normal operations and additional chlorine for oxidation of iron was not added. Operational records obtained from NTUA indicated that approximately 0.30 mg/L of chlorine was added to the well water.

Iron Removal: Overall, 16 pilot runs using the Metalease media were conducted. The pilot runs ranged from 72 hours to 96 hours and filtration unit was operated at 10 gpm/ft^2 loading rate. Since the groundwater iron level was below detection (as shown on Figure 4.4), iron in the effluent from the Metalease filter was below the detection limit. The Metalease filter was included in the pilot due to historical iron levels in the Montezuma Creek wells which have ranged up to 0.75 mg/L in MW1. The pressure loss developed during filtration ranged from 0.5 to 20 psi at the end of filter runs. At the conclusion of each pilot run, filter was backwashed at approximately 12 gpm/ft^2. Iron in the adsorption column effluent was below the detection limit as it was below the detection in the source water.

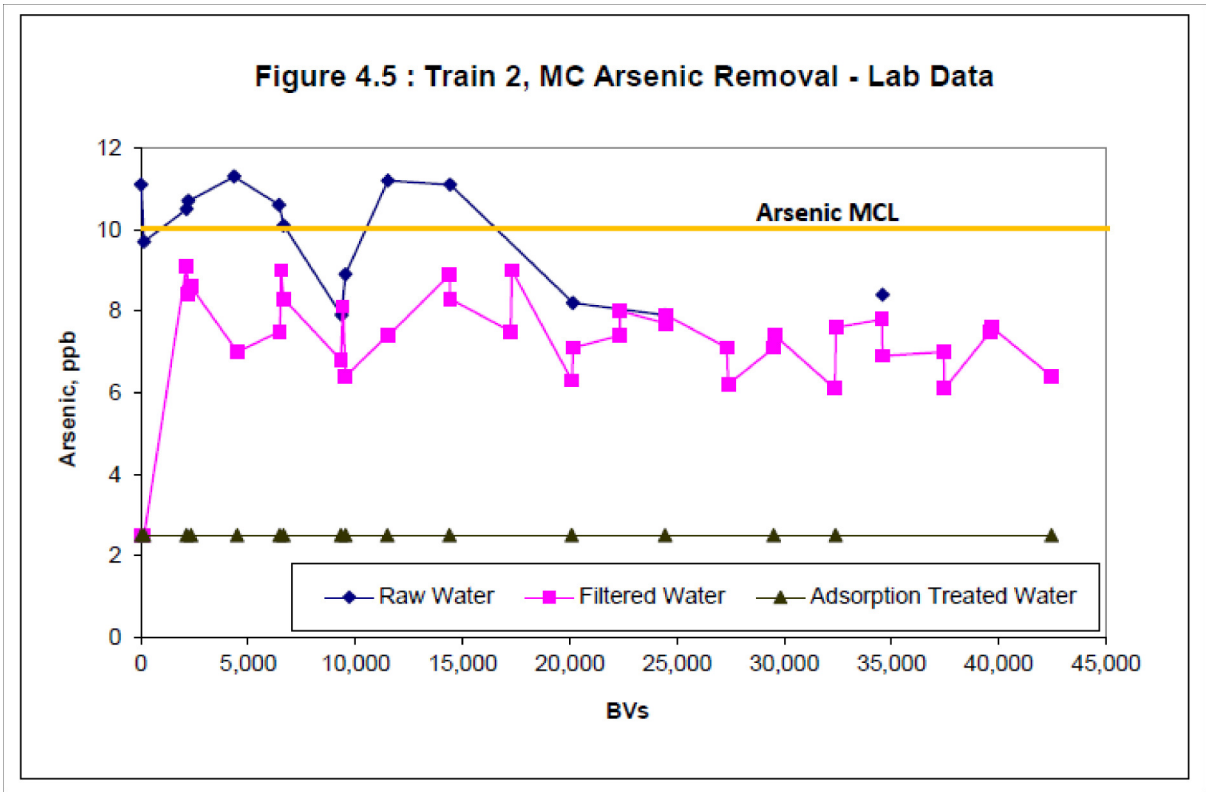


Raw and filtered water iron levels were analyzed in the filed at the beginning and end of cycle. Table 4.6 presents field iron data for raw and filtered water samples. Field data shows complete removal of raw water iron through the metalease filter. Raw water iron level was measured in the range of 0.03 to 0.66 mg/L with an average of 0.22 mg/L. And the filtered water iron level was measured in the range of 0 to 0.28 mg/L with an average of 0.05 mg/L.

Arsenic Removal: Similar to Aneth, arsenic was removed by the Metalease media and the media was reactivated during backwash. However, as shown on Figure 4.5, the arsenic level in the filter effluent did not decrease with the backwash of Metalease filter as was seen for the Aneth filter up to 10,000 BVs. The Metalease media removes arsenic to below 8 ppb (with 20% safety factor for arsenic MCL of 10 ppb) for the first six pilot runs but the behavior of the next 10 runs was different. The arsenic level of 9.1 ppb is below the arsenic MCL but does not provide a safety factor (typical 20%) if the well arsenic level increased beyond that was observed during the pilot testing.

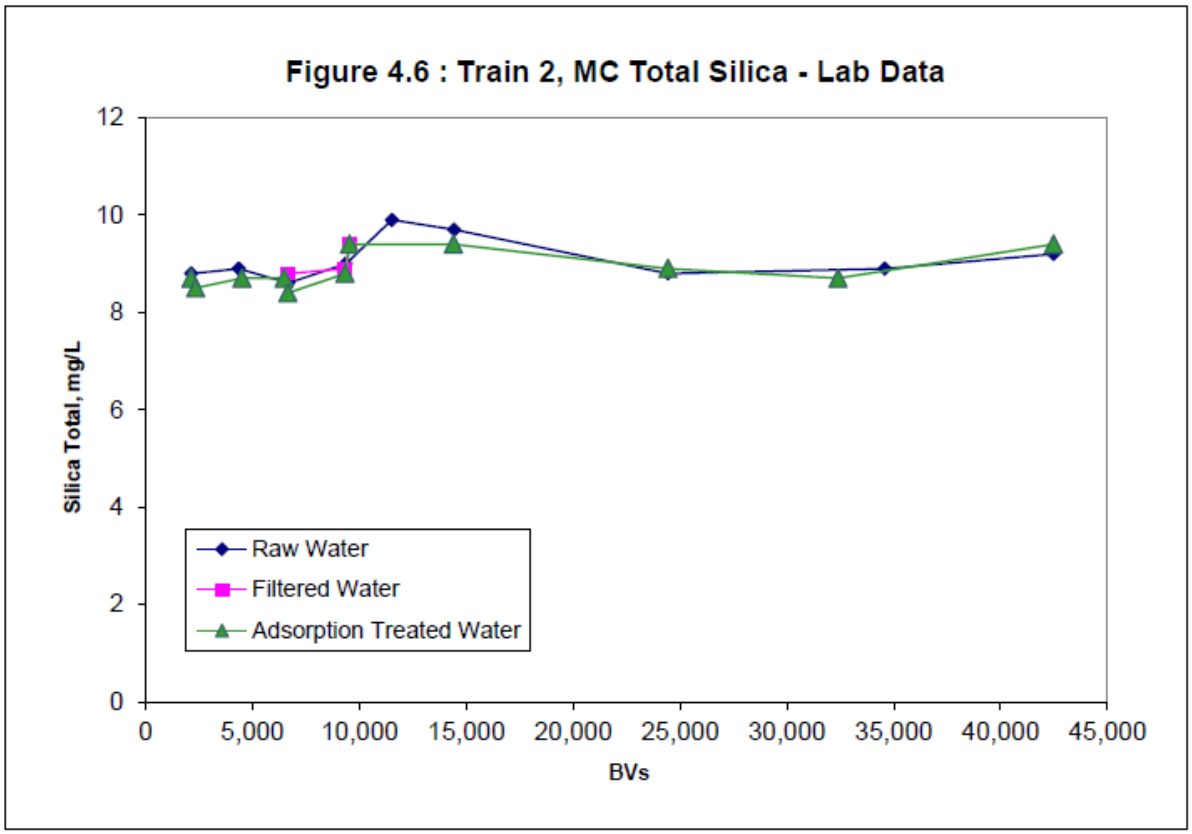
Table 4.6 : Montezuma Creek Field Iron Data

Run #	Well Water			Filtered Water		
	Date	Hour	Iron, mg/L	Date	Hour	Iron, mg/L
Run 1	08/09/16	30 minute	0.52	08/09/16	30 minute	0.09
				08/09/16	4 Hr	0.11
	08/12/16	72 Hr	0.23	08/12/16	72 Hr	0.08
Run 2	08/12/16	30 minute	0.23	08/12/16	30 minute	0.09
				08/12/16	4 Hr	0.04
	08/15/16	72 Hr	0.66	08/15/16	72 Hr	0.00
Run 3	08/15/16	30 minute	0.66	08/15/16	30 minute	0.00
				08/15/16	4 Hr	0.00
	08/18/16	72 Hr	0.23	08/18/16	72 Hr	0.00
Run 4				08/18/16	30 minute	0.28
	08/18/16	4 Hr	0.32	08/18/16	4 Hr	0.07
	08/22/16	96 Hr	0.06	08/22/16	96 Hr	0.00
Run 5				08/22/16	30 minute	0.16
	08/22/16	4 Hr	0.24	08/22/16	4 Hr	0.00
	08/25/16	72 Hr	0.30	08/25/16	72 Hr	0.07
Run 6	08/25/16	30 minute	0.30	08/25/16	30 minute	0.09
	08/29/16	96 Hr	0.25	08/29/16	96 Hr	
Run 7	08/29/16	30 minute	0.20	08/29/16	30 minute	0.05
	09/02/16	96 Hr	0.23	09/02/16	96 Hr	0.02
Run 8	09/02/16	30 minute	0.20	09/02/16	30 minute	0.07
	09/06/16	96 Hr	0.08	09/06/16	96 Hr	0.00
Run 9	09/06/16	30 minute	0.54	09/06/16	30 minute	
	09/09/16	72 Hr	0.10	09/09/16	72 Hr	0.23
Run 10	09/09/16	30 minute		09/09/16	30 minute	0.03
	09/12/16	72 hr	0.08	09/12/16	72 Hr	0.01
Run 11	09/12/16	30 minute	0.10	09/12/16	30 minute	0.00
	09/16/16	96 Hr	0.13	09/16/16	96 Hr	0.02
Run 12	09/16/16	30 minute	0.24	09/16/16	30 minute	0.02
	09/19/16	72 Hr	0.03	09/19/16	72 Hr	0.01
Run 13	09/19/16	30 minute	0.09	09/19/16	30 minute	0.02
	09/23/16	96 Hr	0.18	09/23/16	96 Hr	0.02
Run 14	09/23/16	30 minute	0.19	09/23/16	30 minute	0.11
	09/26/16	72 Hr	0.18	09/26/16	72 Hr	0.00
Run 15	09/26/16	30 minute	0.10	09/26/16	30 minute	0.01
	09/30/16	96 Hr	0.04	09/30/16	96 Hr	0.15
Run 16	09/30/16	30 minute	0.05	09/30/16	30 minute	0.02
	10/03/16	72 Hr	0.17	10/03/16	72 Hr	0.05
		Minimum =	0.03		Minimum =	0.00
		Maximum =	0.66		Maximum =	0.28
		Average =	0.22		Average =	0.05



As shown on Figure 4.5, the E-33 adsorption media (with an EBCT of 1.5 minutes) removed the filtered water arsenic level to below the detection limit (5 ppb) for up to 42,480 BVs. For the pilot Train 2, the E-33 media behaved as a polishing filter and provides a safety factor if the arsenic level increased in the groundwater. The arsenic breakthrough (arsenic level above detection limit) was not observed during the pilot testing period.

Impact on Arsenic Removal due to Silica: Figure 4.6 shows the silica breakthrough through the Metalease and E-33 media. Similar to Aneth, both media result in a minor reduction of silica and the media were saturated with silica at around 10,000 BVs. Based on the well water silica level and non-breakthrough of arsenic from E-33 column, it appears that silica does not appear to impact the arsenic removal by E-33 media.



As described under the Aneth pilot testing results, the E-33 media is capable of treating more than 100,000 BVs of water, however, similar to Aneth, the projected treatment capacity is estimated at a minimum of 85,000 BVs at Montezuma Creek.

Impact on Other Water Quality Parameters: Tables 4.7 and 4.8 present water quality observed for Filtered and Adsorption treated water during the pilot testing. It shows that other than arsenic, iron, manganese, and turbidity, all other water quality parameters (including calcium, fluoride, magnesium, pH, alkalinity) were not affected by the treatment process.

Table 4.7 : MC Filtered Water Quality during Pilot Testing

Parameter	Units	Range	Average
Arsenic	ppb	2.5 - 9.1	7.2
Calcium	mg/L	23 - 32	28
Fluoride	mg/L	0.82 - 0.94	0.88
Iron	mg/L	ND	ND
Magnesium	mg/L	11 - 20	15
Manganese	mg/L	0.05	0.05
pH (Field)	Std. Unit	7.6 - 8.5	8.1
Silica, Total	mg/L	8.8 - 9.4	9.0
Temperature (Field)	^{o}C	18 - 22	21
Total Alkalinity as $CaCO_3$	mg/L	389 - 482	422
Turbidity (Field)	NTU	0.16 - 0.74	0.34

ND means Non Detect.

Table 4.8 : MC Adsorption Treated Water Quality during Pilot Testing

Parameter	Units	Range	Average
Arsenic	ppb	2.5	2.5
Calcium	mg/L	22 - 32	27
Fluoride	mg/L	0.81 - 1.06	0.94
Iron	mg/L	ND	ND
Magnesium	mg/L	10 - 20	14
Manganese	mg/L	0.05	0.05
pH (Field)	Std. Unit	7.7 - 8.3	8.0
Silica, Total	mg/L	8.4 - 9.4	8.8
Temperature (Field)	^{o}C	20 - 23	21
Total Alkalinity as $CaCO_3$	mg/L	376 - 478	430
Total Phosphorous	mg/L	25	25
Turbidity (Field)	NTU	0.15 - 0.45	0.25
Vanadium	ppb	17.5	17.5

ND means Non Detect.

APPENDIX A

ANETH AND MC PILOT TESTING LAB DATA

Table A1 : Aneth Pilot Testing Lab Data

Aneth Well	Units	08/09/16	08/12/16	08/12/16	08/18/16	08/22/16	08/25/16	08/29/16	09/12/16	09/26/16	10/07/16	Minimum	Maximum	Average
Calcium	mg/L	34	35	35	34	35	36	37	34			34	37	35
Fluoride	mg/L	0.48		0.38	0.39	0.39	0.42	0.43				0.38	0.48	0.42
Magnesium	mg/L	19	19	19	19	19	19	19	18			18	19	18.9
Manganese	mg/L	0.22	0.05	0.05	0.05	0.05	0.05	0.05	0.05			0.05	0.22	0.07
Silica, Total	mg/L	9.3	9.4	9.4	9.2	9.3	9.4	9.5	8.9			8.9	9.5	9.3
Sulfate	mg/L							45.6				45.6	45.6	45.6
Total Alkalinity as CaCO3	mg/L	422		374	423	422	402	423	397			374	423	409
Total Phosphorous	ppb							25	25			25	25	25
Vanadium	ppb							17.5	17.5	17.5	17.5	17.5	17.5	17.5

Aneth Filtered	Units	08/12/16	08/15/16	08/15/16	08/18/16	08/22/16	Minimum	Maximum	Average
Calcium	mg/L	34	34	35	35	37	34	37	35
Fluoride	mg/L				0.39	0.42	0.39	0.42	0.41
Magnesium	mg/L	18	18	19	19	19	18	19	18.6
Manganese	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Silica, Total	mg/L	9	8.9	9.5	9.4	9.4	8.9	9.5	9.2
Total Alkalinity as CaCO3	mg/L				424	422	422	424	423
Vanadium	ppb					17.5	17.5	17.5	17.5

Aneth Treated	Units	08/12/16	08/12/16	08/15/16	08/18/16	08/18/16	08/22/16	08/22/16	08/29/16	09/12/16	09/26/16	10/07/16	Minimum	Maximum	Average
Calcium	mg/L	35	32	34	35	35	35	37		35			32	37	35
Fluoride	mg/L	0.39	0.45	0.39	0.39	0.4	0.4	0.46					0.39	0.46	0.41
Magnesium	mg/L	19	17	18	19	19	19	19		19			17	19	18.6
Manganese	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.05	0.05	0.05	0.05
Silica, Total	mg/L	9	8.8	9.1	9.2	9.4	9.3	9.3	9.4	9.1		6	6	9.4	8.9
Total Alkalinity as CaCO3	mg/L	405	394	417	419	421	423	405					394	423	412
Total Phosphorous	ppb								25	25		25	25	25	25
Vanadium	ppb								17.5	17.5	17.5	17.5	17.5	17.5	17.5

Table A2 : Montezuma Creek Pilot Testing Lab Data

MC Well	Units	08/12/16	08/15/16	08/18/16	08/22/16	08/25/16	08/29/16	09/12/16	09/16/16	09/26/16	10/07/16	Minimum	Maximum	Average
Calcium	mg/L	32	32	31	24	34	35	26				24	35	31
Fluoride	mg/L	0.94	0.93	0.94	0.89		1.06					0.89	1.06	0.95
Magnesium	mg/L	20	20	19	11	22	22	12				11	22	18.0
Manganese	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.05	0.05	0.05	0.05	0.05
Sulfate	mg/L								258			258	258	258
Total Alkalinity as CaCO3	mg/L		444	466	389		459	379				379	466	427
Total Phosphorous	ppb						25	80		25	25	25	80	39
Total Silica	mg/L	8.8	8.9	8.6	9	9.9	9.7	8.8		8.9	9.2	8.6	9.9	9.1
Vanadium	ppb						17.5	17.5		17.5	17.5	17.5	17.5	17.5

MC Filtered	Units	08/18/16	08/22/16	08/22/16	Minimum	Maximum	Average
Calcium	mg/L	32	23	29	23	32	28
Fluoride	mg/L	0.94	0.82	0.89	0.82	0.94	0.88
Magnesium	mg/L	20	11	14	11	20	15
Manganese	mg/L	0.05	0.05	0.05	0.05	0.05	0.05
Total Alkalinity as CaCO3	mg/L	482	396	389	389	482	422
Total Silica	mg/L	8.8	8.9	9.4	8.8	9.4	9.0

MC Treated	Units	08/12/16	08/12/16	08/15/16	08/18/16	08/18/16	08/22/16	08/22/16	08/29/16	09/12/16	09/23/16	10/07/16	Minimum	Maximum	Average
Calcium	mg/L	32	22	28	32	23	23	29		26			22	32	27
Fluoride	mg/L	0.96	1.06	0.81	0.93	0.97		0.89					0.81	1.06	0.94
Magnesium	mg/L	20	12	13	20	14	10	14		12			10	20	14
Manganese	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.05	0.05	0.05
Total Alkalinity as CaCO3	mg/L	449	450	402	470	478	386			376			376	478	430
Total Phosphorous	ppb								25	25			25	25	25
Total Silica	mg/L	8.7	8.5	8.7	8.7	8.4	8.8	9.4	9.4	8.9	8.7		8.4	9.4	8.8
Vanadium	ppb								17.5	17.5	17.5	17.5	17.5	17.5	17.5

APPENDIX B

ANETH PILOT TESTING FIELD DATA

Table B1 : Aneth Raw Water

				30 Min											4 Hr							
Date	**Time**	**Operator**	**Well(s) in Operation**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Comments**	**Date**	**Time**	**Operator**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Comments**
				gpm	**Std Unit**	**°C**	**NTU**	**mg/L**	**ppb**	**mg/L**					**gpm**	**Std Unit**	**°C**	**NTU**	**mg/L**	**ppb**	**mg/L**	
8/4/2016	12pm	KJ		8	-	-	-	-	-	-	Backwash system both metalease filters for 30 min @ 10gpm	-	-	-	-	-	-	-	-	-	-	No Data
8/5/2016	6am	AA		8	-	-	-	-	-	-	Stopped the system at 6am on 8/5	-	-	-	-	-	-	-	-	-	-	No Data
8/9/2016	1pm	KJ		8	8.4	22	1.16	0.06	-	0.46	No Arsenic Test	8/9/2016	**5pm**		8	8.3	22	0.74	0.04	-	0.49	
				30 min											**72 hr**							
8/12/2016	2pm	KJ		8	8.1	22	1.03	1	8	0.5	Started backwash at 1pm for 30 min.	8/12/2016	2pm		8	8.1	22	1.03	1	8	0.5	
8/15/2016	6pm	KJ		8	8.4	22.5	0.61	0.16	8	0	Started backwash at 1pm for 30 min.	8/18/2016	2pm		8	8.4	21	0.67	0.11	11	0.54	
				4 Hr											**96 hr**							
8/18/2016	6pm	KJ		8	8.2	21	0.41	0.03	11	0.51	Started backwash at 1pm for 30 min.	8/22/2016	1pm		8	8.5	21	0.86	0.03	9	0.12	
				4 Hr											**72 hr**							
8/22/2016	6pm	KJ		8	8.4	21.5	0.32	0.03	<2	0.4	Started backwash at 1pm for 30 min.	8/25/2016	1pm		8	8.1	21	0.47	0.04	10	0.48	
				30 min											**96 hr**							
8/25/2016	10am	KJ		8	8.1	21	0.47	0.04	10	0.48	Backwash started at 1pm for 30 min.	8/29/2016	1pm	KJ	8	8.1	21	0.73	0	12	0.45	Backwash started at 1pm for 30 min.
8/29/2016	11am	KJ		8	8.3	21	0.44	0.03	12	0.47	Backwash started at 1pm for 30 min; Water pressure was low, NTUA had turned off water supply to the pilot system and did not return pressure to 8gpm.	9/2/2016	12pm	KJ	2	7.9	21	0.58	0.05	12	0.46	Backwash started at 1pm for 30 min; Water pressure was low, NTUA had turned off water supply to the pilot system and did not return pressure to 8gpm.
9/2/2016	11am	KJ		8	8	21	0.52	0.05	12	0.46	Backwash started at 12pm at 11gpm for 30 min.	9/6/2016	11am	KJ	8	8.1	21.5	0.47	0.05	10	0.62	Backwash started at 12pm at 11gpm for 30 min.
				30 min											**72 hr**							
9/6/2016	10am	KJ		8	7.9	20.5	0.48	0.05	12	0.46	Backwash started at 11:30am for 30 minutes at 11gpm	9/9/2016	12pm	KJ	7.5	8.3	21.5	0.79	0.01	8	0.52	Backwash started at 11:30am for 30 minutes at 11gpm
9/9/2016	11am	KJ		8	8.3	20.5	0.78	0	12	0.5	Backwash started at 1pm for 30 minutes at 11gpm	9/12/2016	12:30p	KJ	8	8.3	20.5	0.36	0.01	3	0.46	Backwash started at 1pm for 30 minutes at 11gpm
				30 min											**96 hr**							
9/12/2016	11am	KJ		8	8.3	22	0.34	0.15	9	0.07	Backwash started at 1pm at 11.5gpm for 30 min.	9/16/2016	1pm	KJ	7.5	8.5	20.5	0.68	0.02	7	0.49	Backwash started at 1pm at 11.5gpm for 30 min.
				30 min											**72 hr**							
9/16/2016	11am	KJ		8	8.4	20.5	0.48	0.01	16	0.5	Backwash started at 12:50p @ 11.5 gpm for 30 minutes on 9/16	9/19/2016	2pm	KJ	7.5	8.1	20.5	0.41	0.02	10	0.47	Backwash started at 12:50p @ 11.5 gpm for 30 minutes on 9/16
				30 min											**96 hr**							
9/19/2016	12pm	KJ		8	7.6	20.5	0.29	0.02	9	0.45	Backwash started at 2pm @ 11.5 gpm for 30 min. on 9/19	9/23/2016	12pm	KJ	7.75	8.3	20	0.28	0.15	12	0.49	Backwash started at 2pm @ 11.5 gpm for 30 min. on 9/19
				30 min											**72 hr**							
9/23/2016	11am	KJ		8	8.2	19.5	0.38	0.33	8	0.47	Started backwash at 12:30pm for 30 min @ 12gpm	9/26/2016	2pm	KJ	8	7.9	20.5	1.54	0.01	10	0.45	
				30 min											**96 hr**							
9/26/2016	3pm	KJ		8	8	21	0.42	0.01	9	0.45	Started backwash at 1:40p @ 11gpm for 30 min.	9/30/2016	1pm	KJ	8	7.8	20	0.32	0.01	10	0.45	
				30 min											**72 hr**							
9/30/2016	2pm	KJ		8	8.1	20.5	0.27	0.01	12	0.48	Started backwash at 12:40p @ 11.5gpm for 30 min.	10/3/2016	2pm	KJ	8	7.8	19	0.28	0.02	16	0.44	
				30 min											**96 hr**							
10/3/2016	2pm	KJ		8	8.4	20	0.24	0	12	0.46	Started backwash at 1:45p @ 11.5gpm for 30 min.											

Table B2 : Aneth Filtered Water

			30 min										4 hr										72 hr										
Date	**Time**	**Operator**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**		**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**		**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**		**Comments**
			gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi		gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi		gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi		
8/9/2016	1pm	KJ	8	8.4	22	1.12	0.04	-	0.06	5	0	5	8	8.1	23	0.38	0	-	0	5	0		8	8	22	0.82	0	0	0.16	10	0	10	As = No color change to indicator
8/12/2016	2pm	KJ	8	7.7	25	0.69	0.72	3	0.04	5	0	5	8	8.4	22.5	0.61	0.44	<2	0.07	7	0		8	8.1	22	0.74	0	<2	0.07	7	0	7	
8/15/2016	2pm	KJ	8	8.3	21.5	0.72	0.03	5	0.46	7	0	7	8	7.9	21.5	0.48	0.04	<2	0.07	7	0		8	8.2	21	0.59	0.05	8	0.27	14	4	10	
			30 min										**4 hr**										**96 hr**										
8/18/2016	3pm	KJ	8	8.1	21	0.34	0.06	11	0.11	7	0	7	8	8.2	21	0.38	0.15	<2	0.1	10	5		8	8.4	20.5	0.26	0.03	<2	0.05	16	5	11	Started System at 1:30p for 30 min.
			30 min										**4 hr**										**72 hr**										
8/22/2016	2pm	KJ	8	8	21	0.49	0.03	8	0.05	10	5	5	8	8.2	21.5	0.37	0.03	<2	0.04	10	6		8	8.3	21	0.3	0.03	7	0.04	10	5	5	Started System at 1:30p for 30 min.

Date	Time	Operator	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure			Date	Time	Operator	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure		Comments
			30 min														**96 hr**										
8/25/2016	11am	KJ	8	8.4	18	0.59	0.05	<2	0.09	9	5	4	System started at 1:30p for 30 min. @ 8gpm	8/29/2016	2pm	KJ	8	8.2	21	0.22	0.04	8	0.02	10	5.5	4.5	
8/29/2016	2pm	KJ	8	8.1	21	0.31	0	7	0.05	9.5	5	4.5	System started at 1:30p for 30 min. @ 8gpm	9/2/2016	12pm	KJ	2	7.9	21.5	0.27	0.03	0	0.07	0	0		
9/2/2016	1pm	KJ	8	7.9	21	0.29	0.04	7	0.05	10	5.5	4.5	System started at 12:30pm at 8gpm for 30 min.	9/6/2016	11am	KJ	8	8.4	21.5	0.36	0.04	7	0.24	18	6	12	
			30 min														**72 hr**										
9/6/2016	1pm	KJ	8	7.9	21	0.37	0.03	3	0.07	11	6	5	System started at 12pm at 8gpm for 30 minutes	9/9/2016	12pm	KJ	7.5	8.5	20.5	0.4	0.01	0	0.18	14	7	7	
9/9/2016	1pm	KJ	8	8.1	21	0.27	0.02	3	0.35	11	6.5	4.5	TR2 started at 1pm @ 8gpm for 30 min.	9/12/2016	1pm	KJ	8	7.9	20.5	0.26	0.02	0	0.11	17	7	10	
			30 min														**96 hr**										
9/12/2016	2pm	KJ	8	8.4	22	0.34	0.21	<2	0.06	12	7	5	TR2 started at 1:30pm @ 8gpm for 30 min. on 9/12/16	9/16/2016	1pm	KJ	7.5	8.2	20.5	0.23	0.17	5	0.1	17	7	10	
			30 min														**72 hr**										
9/16/2016	2pm	KJ	8	8.2	20.5	0.23	0	8	0.07	12	8	4	TR2 started at 1:20pm @ 8 gpm for 30 min. on 9/16/16	9/19/2016	2pm	KJ	7.5	8.1	20.5	0.31	0.04	5	0.09	15	7	8	
			30 min														**96 hr**										
9/19/2016	3pm	KJ	8	7.6	20.5	0.16	0.04	5	0.14	12	8	4	TR2 started at 2:30p @ 8gpm for 30 min. on 9/19/16	9/23/2016	12pm	KJ	8	7.6	20.5	0.16	0.04	5	0.14	12	8	4	
			30 min														**72 hr**										
9/23/2016	2pm	KJ	8	7.9	20	0.18	0.01	7	0.05	11	7	4	Started TR2 at 1pm @ 8gpm for 30 min. Tests at 1:40p	9/26/2016	2pm	KJ	8	7.8	20.5	0.2	0.07	3	0.09	11	6	5	
			30 min														**96 hr**										
9/26/2016	3pm	KJ	8	7.8	21	0.19	0.02	3	0.23	10	5	5	Started TR2 at 2:15p for 30 min. at 8 gpm	9/30/2016	10am	KJ	8	7.9	20	0.31	0.01	10	0.12	12	6	6	
			30 min														**72 hr**										
9/30/2016	2pm	KJ	8	7.9	20.5	0.23	0.01	10	0.08	10	6	4	Started TR2 at 1:15pm @ 8gpm for 30 min.	10/3/2016	2pm	KJ	8	7.9	19.5	0.18	0	8	0.1	10	5	5	
			30 min														**96 hr**										
10/3/2016		KJ	8	7.9	19	0.46	0	5	0.06	10	6	4	Started TR2 at 2:20pm @ 8gpm for 30 min.	10/7/2016													

Table B3 : Aneth Adsorption Treated Water

Date	Time	Operator	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure	Comments
			4 Hr									72 hr									
			gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	
8/9/2016	1pm	KJ	8	8	23	0.17	0.05	-	0.04	0	0	8	7.8	23	0.36	0.65	0	0.13	0	0	As = No color change at 72 hr.
8/12/2016	6pm	KJ	8	8.3	21.5	0.36	0.05	<2	0.07	0	0	8	8.3	22.5	0.26	0	<2	0	0	0	As = No color change at 72 hr.
8/15/2016	6pm	KJ	8	8.1	22	0.24	0.03	<2	0.04	0	0	8	8.1	21	0.33	0.05	0	0.13	4	0	As = No color change at 4 hr.
			4 Hr									96 hr									
8/18/2016	7pm	KJ	8	8	21	0.23	0.04	0	0.06	5	0	8	7.9	21	0.19	0	0	0.03	0	0	As = No color change at 4 hr and 96 hr.
			4 Hr									72 hr									
8/22/2016	6pm	KJ	8	8.1	21.5	0.45	0.02	<2	0.12	5	0	8	8.1	21.5	0.45	0.02	<2	0.12	5	0	

Date	Time	Operator	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure	Comments
			96 hr									
8/29/2016	10am	KJ	8	8.2	21.5	0.26	0	0	0.04	5	0	
9/2/2016	12pm	KJ	2	8	22	0.24	0.02	0	0.09	0	0	Low pressure per NTUA disturbing water pressure, not
9/6/2016	11am	KJ	8	7.8	22	0.25	0.27	<2	0.44	0	0	
			72 hr									
9/9/2016	12pm	KJ	7.5	8.1	20.5	0.16	0.01	0	0.04	5	0	
9/12/2016	1pm	KJ	8	7.7	20.5	0.22	0	0	0	7	0	
			96 hr									
9/16/2016	1pm	KJ	7.5	8.1	20.5	0.41	0.02	0	0.02	7	0	
			72 hr									
9/19/2016	2pm	KJ	7.5	8	21	0.21	0.01	0	0.03	5	0	
			96 hr									
9/23/2016	2pm	KJ	7.75	8	20	0.22	0.04	0	0.01	7	0	
			72 hr									
9/26/2016	2pm	KJ	8	7.8	20.5	0.18	0.03	0	0.02	6	0	
			96 hr									
9/23/2016	2pm	KJ	7.75	8	20	0.22	0.04	0	0.01	7	0	
			72 hr									
9/26/2016	2pm	KJ	8	7.8	20.5	0.18	0.03	0	0.02	6	0	
			96 hr									
9/30/2016	2pm	KJ	7.75	8	20	0.22	0.04	0	0.01	7	0	
			72 hr									
10/3/2016	2pm	KJ	8	8.2	20	0.15	0	0	0.13	5	0	
			96 hr									
10/7/2016		KJ										

APPENDIX C

MONTEZUMA CREEK PILOT TESTING FIELD DATA

Table C1 : Montezuma Creek Raw Water

				30 Min											15 Hr							
Date	**Time**	**Operator**	**Well(s) in Operation**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Comments**	**Date**	**Time**	**Operator**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Comments**
				gpm	**Std Unit**	**°C**	**NTU**	**mg/L**	**ppb**	**mg/L**					**gpm**	**Std Unit**	**°C**	**NTU**	**mg/L**	**ppb**	**mg/L**	
8/4/2016	3pm	AA		8	8.3	22	0.89	0.02	-	0.11	System started at 3pm on 8/4; No 72 Hr Data Retrieved	8/5/2016	7am	AA	8	8.1	20.5	-	0.73	-	0.28	No Arsenic Test; (15 Hr Test) Turbidimeter No Batteries; No Arsenic Test; System stopped the system at 8am.
				30 min														**72 hr**				
8/9/2016	11am	KJ		8	8.5	19.5	1.89	2.2	-	0.52	Backwash started at 10am for 30 min.; TR-2 started at 10:30a. No Arsenic Test on 30 min Run	8/12/2016	12pm	KJ	8	8.1	21	0.85	0.07	5	0.23	
8/12/2016	12pm	KJ		8	8.1	21	0.85	0.07	5	0.23	Backwash started at 11am for 30 min.; Started TR-2 at 11am ran for 30 min. Samples collected at 12pm and 4pm.	8/15/2016	11am	KJ	8	8.6	18.5	0.67	0.09	8	0.66	
8/15/2016	12pm	KJ		8	8.6	18.5	0.67	0.09	8	0.66	Backwash started at 10:00am on 8/15 for 30 min. Started TR-2 at 10:30a. Collected samples at 11am.	8/18/2016	9am	KJ	8	8.4	18.5	0.47	0.004	5	0.23	
				4 Hr														**96 hr**				
8/18/2016	4pm	KJ		8	8.3	18	0.61	2.2	8	0.32	Backwash started at 11am for 30 min.	8/22/2016	9am	KJ	8	8.3	23	0.28	0.03	8	0.06	Raw Water sample taken at 96 hr on 8/22/16
				4 Hr														**72 hr**				
8/22/2016	4pm	KJ		8	8.6	18.5	1.52	0.09	9	0.24	Started Backwash at 10:30a for 30 min.	8/25/2016	9am	KJ	8	8.5	17.5	0.68	0.03	8	0.3	
				30 min														**96 hr**				
8/25/2016	10am	KJ		8	8.5	17.5	0.68	0.03	8	0.3	Started backwash at 9:30am for 30 min.	8/29/2016	10am	KJ	8	18.4	17.5	0.61	0.02	5	0.25	
8/29/2016	11am	KJ		8	8.4	17.5	0.6	0	5	0.2	Started backwash started at 10am for 30 minutes.	9/2/2016	9am	KJ	8	8.6	17	0.81	0.17	5	0.23	
9/2/2016	11am	KJ		8	7.9	17.5	0.61	0.11	5	0.2	Started backwash at 10am for 30 minutes	9/6/2016	9am	KJ	8	8.5	17,5	0.39	0.1	3	0.08	
				30 min														**72 hr**				
9/6/2016	10am	KJ		8	8.5	18	0.46	0.39	7	0.54	Backwash started at 8:30am at 12gpm for 30 minutes	9/9/2016	10am	KJ	7	8.6	22	0.69	1.75	5	0.1	
9/9/2016	11am	KJ		8	8.5	22	0.5	1.3	5	1	Backwash started at 10am at 12gpm for 30 minutes	9/12/2016	9am	KJ	8	8.6	22	0.31	0.65	5	0.08	
				30 min														**96 hr**				
9/12/2016	11am	KJ		8	8.6	22	0.83	0.15	12	0.1	Backwash started at 10am at 12gpm for 30 minutes	9/16/2016	9am	KJ	8.25	8.7	21	0.51	0.04	7	0.13	
				30 min														**72 hr**				
9/16/2016	11am	KJ		8	8.9	18	0.27	0.01	3	0.24	Backwash started at 9.45a on 9/16 @ 12gpm for 30 min.	9/19/2016	10am	KJ	8	7.6	21	0.27	0.03	9	0.03	
				30 min														**96 hr**				
9/19/2016	12pm	KJ		8	8.2	21.5	0.55	0.05	8	0.09	Backwash started at 10:30a @ 12 gpm for 30min on 9/19	9/23/2016	9am	KJ	0	7.7	16	0.51	1.22	0	0.18	
				30 min														**72 hr**				
9/23/2016	11am	KJ		8	8.3	16.5	0.61	0.56	8	0.19	Backwash started at 9:30am on 9/23 @ 12gpm for 30 min.	9/26/2016	10am	KJ	8	8.3	17	1.02	0.01	5	0.18	
				30 min														**96 hr**				
9/26/2016	11am	KJ		8	8.3	17.5	0.5	0.01	7	0.1	Started BW @ 10am @ 12gpm for 30 min.	9/30/2016	10am	KJ	8	8	20.5	0.48	0.004	3	0.04	
				30 min														**72 hr**				
9/30/2016	11am	KJ		8	8.4	21.5	0.51	0.36	9	0.05	Started BW @ 10:15am @ 12gpm for 30 min.	10/3/2016	11am	KJ	8	8.3	16.5	0.53	0.22	5	0.17	
				30 min														**96 hr**				
10/3/2016	1pm	KJ		8	8.4	16.5	0.55	0.2	5	0.06	Started BW @ 11:35am @ 12gpm for 30 min.	10/7/2016										

Table C2 : Montezuma Creek Filtered Water

			30 min									4 hr									72 hr									
Date	**Time**	**Operator**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**	**Comments**
			gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	
8/4/2016	4pm	AA	8	8.2	22.5	1.69	0.04	-	0.04	6	2.5	8	8.2	21.5	-	0.47	-	0.04	8	3										No Arsenic Tests
8/5/2016	7am	AA	8	8.2	21.5	-	0.47	-	0.04																					No Arsenic Tests
8/9/2016	11am	KJ	8	8.3	19	2.23	2.03	-	0.087	5.5	0	8	8.1	18.5	1.14	2.2	-	0.11	5.5	0	8	8.1	18	0.83	0.19	3	0.08	10.5	3	No Arsenic Tests
8/12/2016	12pm	KJ	8	8.3	19	1.68	0.39	0	0.09	6.5	3	8	8.5	20	0.7	0.07	8	0.04	8	1	8	8.5	18	0.23	0.6	5	0	26.5	2.5	As = No color change at 30 min.
8/15/2016	12pm	KJ	8	8.4	18	0.59	0.02	7	0	7	3	8	8.3	20.5	0.65	0.04	7	0	7.5	2.5	8	8.5	18	0.31	0.03	5	0	15	4	NTUA added Chlorine at 11am before system backwash.
			30 min									4 hr									96 hr									
8/18/2016	12pm	KJ	8	8.3	19.5	0.83	2.2	7	0.28	8	4	8	8.3	19.5	0.4	2.2	7	0.07	8	4	8	8.4	23.5	0.27	0.1	<2	0	9.5	4	System started at 11:30a for 30 min
			30 min									4 hr									72 hr									
8/22/2016	12pm	KJ	8	8.3	18.5	1.15	0.03	<2	0.16	9.5	5	8	8.4	19.5	0.41	0.03	<2	0	8	4	8	8.5	17.5	0.39	0.03	5	0.07	10	4	Started system at 11am for 30 min. prior to taking samples for filtered water

Date	**Time**	**Operator**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**	**Comments**	**Date**	**Time**	**Operator**	**Flow Rate**	**pH**	**Temp**	**Turbidity**	**Free Chlorine**	**Arsenic**	**Iron**	**Inlet Pressure**	**Outlet Pressure**	**Comments**
			gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	gpm Std Unit °C NTU mg/L ppb	mg/L	psi	psi	gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	
			30 min													96 hr									
8/25/2016	11am	KJ	8	8.4	18	0.59	0.05	<2	0.09	9	5	System started at 10am for 30 minutes on 8/25	8/29/2016	10am	KJ	8	8.4	18	0.9	0.03	3	0.35	14.5	5.5	
8/29/2016	11am	KJ	8	8.3	17.5	0.47	0.06	3	0.05	9.5	5.5	System started at 10am for 30 minutes on 8/25	9/2/2016	11am	KJ	8	8.3	17	0.27	0.23	5	0.02	11	4	
9/2/2016	11am	KJ	8	8	17.5	0.75	0.15	3	0.07	9	5	Backwash started at 9:20a at 12gpm for 30 minutes	9/6/2016	8am	KJ	8	8.7	17.5	0.68	0	5	0	14	7	
			30 min													72 hr									
9/6/2016	10am	KJ	8	8.4	17.5	0.33	0.04	5	0.58	10	6.5	Backwash started at 8:30am at 12gpm for 30 minutes	9/9/2016	10am	KJ	7	8.2	21.5	0.44	1.22	3	0.23	13	6	
9/9/2016	11am	KJ	8	8.2	22.5	0.43	1.18	3	0.03	9.5	5.5	Backwash started at 10am at 12gpm for 30 minutes	9/12/2016	10am	KJ	8	8.4	22.5	0.1	0.5	5	0.01	12	6	
			30 min													96 hr									
9/12/2016	11am	KJ	8	8.3	22.5	0.77	0.02	5	0	10	6	Started TR2 @ 10:15a on 9/12 for 30 min. @ 8gpm. Tests at	9/16/2016	9am	KJ	8.25	8.5	21	0.39	0.07	0	0.02	17	7	
			30 min													72 hr									
9/16/2016	11am	KJ	8	8.7	17.5	0.56	0.01	0	0.02	11	7	TR2 started at 9:45 am for 30 minutes on 9/16 @ 8 gpm	9/19/2016	10am	KJ	8	7.5	21	0.21	0.02	5	0.01	11	7	
			30 min													96 hr									
9/19/2016	12pm	KJ	8	8.1	21.5	0.5	0.05	8	0.02	10	6	TR2 started at 11 am for 30 minutes on 9/19	9/23/2016	9am	KJ	0	7.9	15.5	0.18	0.07	0	0.02	3	2.5	Arrived at 9am on 9/23. Water supply was turned OFF. There was minimal pressure through the filtration system.
			30 min													72 hr									
9/23/2016	11am	KJ	8	8.2	16.5	0.48	0.73	3	0.11	12	8	TR2 started at 10am on 9/23 @ 8 gpm for 30 min.	9/26/2016	10am	KJ	8	8.2	16.5	0.29	0.03	0	0	27	7	20 psi headloss at 72hrs.
			30 min													96 hr									
9/26/2016	11am	KJ	8	8.3	17.5	0.26	0	0	0.01	11	7.5	TR2 started at 10:30a @ 8gpm for 30 min.	9/30/2016	10am	KJ	8	7.9	20.5	0.21	0.09	0	0.15	12	7	
			30 min													72 hr									
9/30/2016	11am	KJ	8	8.5	21.5	0.42	0.2	8	0.02	10	6.5	TR2 started at 10:50a @ 8gpm for 30 min.	10/3/2016	11am	KJ	8	8.2	16.5	0.42	0.12	0	0.05	14.5	8.5	
			30 min													96 hr									
10/3/2016	1pm	KJ	8	8.3	16.5	0.48	0	<2	0.06	11.5	8	TR2 started at 12:05pm @ 8gpm for 30 min.	10/7/2016												

Table C3 : Montezuma Creek Adsorption Treated Water

			1 Hr												15 Hr									
Date	Time	Operator	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure	Date	Time	Operator	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure	Comments
			gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi				gpm	Std Unit	°C	NTU	mg/L	ppb	mg/L	psi	psi	
8/4/2016	4pm	KJ	8	8.2	23	0.58	0	-	0	1	0	8/5/2016	7am	KJ	8	8.3	20	-	0.29	-	0.03	0	0	2nd test (15 HR) taken at 7am on 8/5/16
			30 min												4 Hr									
8/9/2016	11am	KJ	8	8.5	18.5	0.27	1.1	-	0.01	2	1	8/12/2016	4pm	KJ	8	8.3	19.5	0.89	2.2	-	0.05	2	2	Data taken at 30 min/ 4hr.
			4 Hr												72 Hr									
8/12/2016	4pm	KJ	8	8.4	19.5	0.23	0.09	5	0.04	1	1	8/15/2016	10am	KJ	8	17.5	0.3	0.19	0.19	0	0	1	1	
8/15/2016	4pm	KJ	8	8.1	19	0.28	0	0	0	0	0	8/18/2016	10am	KJ	8	8.3	18	0.22	0.03	0	0.04	0	0	
			4 hr												96 hr									
8/18/2016	4pm	KJ	8	8.3	20	0.22	2.2	0	0.15	1	1	8/22/2016	9am	KJ	8	8.1	23.5	0.16	0.05	0	0.1	1	1	No change to Arsenic test indicator at 4 hr.
			4 hr												72 hr									
8/22/2016	4pm	KJ	8	8.4	19	0.29	0.03	0	0.03	0	0	8/25/2016	9am	KJ	8	8.3	17.5	0.32	0.02	0	0	0	0	No color change to As test indicator @ 4 HR.

Date	Time	Operator	Flow Rate	pH	Temp	Turbidity	Free Chlorine	Arsenic	Iron	Inlet Pressure	Outlet Pressure	Comments
			96 hr									
8/29/2016	10am	KJ	8	8.2	17	0.27	0.06	0	0.07	0	0	No color change to As test indicator
9/2/2016	9am	KJ	8	8.4	17	0.24	0.05	0	0.01	0	0	No color change to As test indicator
9/6/2016	8am	KJ	8	8.3	17.5	0.32	0.04	0	0.04	0	0	No color change to As test indicator
			72 hr									
9/9/2016	10am	KJ	7	8.1	21	0.27	1.35	0	0	0	0	No color change to As test indicator
9/12/2016	9am	KJ	8	8.2	22.5	0.16	0.49	0	0.1	5	0	No color change to As test indicator
			96 hr									
9/16/2016	9am	KJ	8.25	8.4	21.5	0.27	0.02	0	0.02	5	0	No color change to As test indicator
			72 hr									
9/19/2016	10am	KJ	8	7.6	21	0.43	0.04	0	0.01	5	1	No color change to As test indicator
			96 hr									
9/23/2016	9am	KJ	0	8	16	0.19	0.07	0	0.05	1	1	No color change to As test indicator; No water pressure as system as turned OFF by NTUA
			72 hr									
9/26/2016	10am	KJ	8	8.3	17	0.25	0.01	0	0	4	1	No color change to As test indicator
			96 hr									
9/30/2016	10am	KJ	8	7.8	20.5	0.2	0.01	0	0.15	5	0	No color change to As test indicator
			72 hr									
10/3/2016	11am	KJ	8	8.1	16.5	0.45	0.08	0	0.02	7	0	No color change to As test indicator
			96 hr									
10/7/2016												

SECTION 11407

FILTER VESSELS AND MEDIA INSTALLATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Installation of filter vessels, installation of vessel internals per manufacturers instructions, cathodic protection system, support media, and catalytic media, piping, and associated accessories. CONTRACTOR shall provide all services associated with these activities that are necessary for a proper working installation.

1.02 REFERENCES

A. Manufacturer's installation instructions: The manufacturer shall provide instructions for the erection of the filter vessels, and the vessels shall be erected in strict accordance with these instructions.

B. Related Sections included but are not necessarily limited to:
1. Section 09800 - Special Coatings
2. Section 13221 - Support Media
3. Section 13334 - Magnetic Flow Meters
4. Section 13510 - Cathodic Protection System
5. Section 11406 - Packaged Filtration Systems
6. Section 15075 - Plastic Piping and Tubing
7. Section 15110 - Valves
8. Section 15111 - Ball Valves.

1.03 DESIGN REQUIREMENTS

A. Equipment Mounting and Anchoring:
1. Use 316 S.S. anchor bolts to anchor vessels to footings unless otherwise shown in the Drawings.
2. Vessels shall not be mounted until supportive concrete base has reached full design strength.

1.04 SUBMITTALS

A. Manufacturer's certified drawings.

B. Construction Photos: Additional digital photographs shall be taken during vessel installation (including internal of vessel) in order to have full photographic record of the entire installation process.

PART 2 PRODUCTS

2.01 FILTER VESSELS

A. Treatment vessels fabricated as per Drawings, all required mounting hardware as per manufacturer's recommendations, and all accessories supplied with vessel.

2.02 ACCESSORIES

A. Accessories: Accessories include, manway hatch and cathodic protection.

B. Iron Removal Media: See Section 11406.

C. Arsenic Adsorption Media: See Section 11406.

D. Support Media: See Section 13221.

PART 3 EXECUTION

3.01 EXAMINATION

A. Orientation of vessels will be verified and approved by ENGINEER prior to vessels being anchored.

B. Vessels shall be inspected upon arrival for damage by the Packaged Filtration Supplier (PFS) supplier(s) and ENGINEER.

3.02 INSTALLATION

A. Installation of vessels: PFS supplier(s) shall ensure that vessel is oriented in the correct manner, prior to anchoring. Vessel installation shall meet the requirements of the Drawings and Specifications.

B. Installation of Cathodic protection shall be per PFS supplier instructions.

C. Install vessel internals to vessel according to shop drawings.

D. Installation of iron removal media or arsenic adsorption media:
   1. Place 3-feet of standing water in vessels (above support media) prior to loading the iron removal or arsenic adsorption media. Media shall be placed evenly within the vessels in layers.
   2. CONTRACTOR shall use a potable water pressure spray, with 0.8 mg/L minimum chlorine residual to evenly distribute and consolidate media. CONTRACTOR shall obtain potable water from nearby fire hydrant for this

purpose. Media sacks shall be directly emptied into vessels without use of a pump.

3. Media will be backwashed to remove fines after initial placement under the direction of the ENGINEER.

E. Paint exterior of vessel as per Section 09800.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTIONS

SECTION 13146

PREFABRICATED CONCRETE BUILDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of prefabricated concrete building as shown on the Drawings.

B. All Prefabricated Buildings as specified herein shall be supplied by one Supplier.

C. See Drawings.

1.02 REFERENCES

A. Reference Standards:
1. American Society of Civil Engineers (ASCE) 7-05, Minimum Design Loads for Buildings and Other Structures.
2. American Concrete Institute (ACI-318-08) Building Code Requirements for Reinforced Concrete.
3. International Building Code (IBC).
4. AASHTO Standard Specification for Highway Bridges – Used for bridges, box culverts and underground structures in jurisdictions that specifically require it.
5. ASTM C857 – Standard that specifies the minimum design loads for underground utility structures.
6. ASTM C518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
7. Building Codes and Standards as listed in Section 1.05.

1.03 SYSTEM DESCRIPTION

A. The Prefabricated Building Supplier shall provide a prefabricated building system that is designed to enclose the facilities shown on the drawings and meet IBC requirements.

B. The prefabricated building shall be designed to provide satisfactory performance under service conditions for a period of not less than 20 years.

C. Building Size:
1. Typical Building 1 - 12 ft. wide x 24 ft. long x 10 ft. high (Montezuma Creek Well 1).
2. Typical Building 2 – 12 ft. wide x 24 ft. long x 12 ft. high (Montezuma Creek Well 1).
3. Typical Building 3- 12 ft. wide x 24 ft. long x 12 ft. high (Montezuma Creek Well 3).
4. A cast-in-place concrete foundation shall be provided for all the buildings by the Contractor. The prefabricated building Supplier is responsible for providing the four walls and roof of the building, including other appurtenances to assemble the building and as described in this specification.

D. The prefabricated building shall be designed for the following (in addition to dead loads):
   1. Roof live load of 200 pounds per square foot (psf)
   2. Wind speed of 70 miles per hour
   3. Superimposed Dead Load = 10 psf (includes provision for hanging loads)

E. The design of the foundation for the building will be supplied by the Contractor. HVAC and lighting shall be provided by the Contractor. The Contractor shall coordinate scheduling with the Prefabricated Building Supplier of the concrete slab, electrical work and HVAC to facilitate building construction.

F. The building Supplier shall supply all trim, fasteners and closures necessary to complete the building. Openings shall be provided for electrical conduit, HVAC ducts as shown on the Drawings.

G. Doors
   1. Quantity: Provide one (1) single door, 3 ft. wide x 7 ft. high and one (1) double door, 6 ft. wide x 8 ft. high per Typical Building.
   2. The doors shall be self-framing, self-flashing, steel doors (24 gauge) with level and dead bolt locks, hinges, and thresholds with sweeps. The door shall include a factory powder coat finish with a color to be selected by the Owner during Shop Drawing review.
   3. Doors and frames shall be factory painted with one coat of baked on primer. All doors shall be preassembled in their frames and hardware installed and tested prior to shipment. Final painting of doors shall be done in the field with color to match the wall.

H. There will be no equipment on the roof of the building. The only loads on the interior of building are electric lighting fixtures (not by Building Supplier).

I. Provide one wall opening of 12" x 12" for louver and supply a louver that is the same material and finish as the adjacent material and located as shown on the plans. The louvers shall be designed by the Prefabricated Building Supplier to meet the wind load specified in IBC, 2018.

J. Provide one wall opening of 12" x 12" for exhaust fan and supply an exhaust fan at location as shown on the plans.

1.04 SUBMITTALS

A. The construction drawings and design calculations for the building shall be signed and sealed by a structural engineer registered in the State of Arizona or at the location of the work. This information is required within four weeks of Contract Award. Plan and elevation drawings of all four exterior sides of the building are required.

B. Submit in accordance with Specification Section 01340 and Shop Drawings covering the items included under this Section. Shop Drawings submittals shall include:
   1. Product Data: Submit manufacturer's specifications and instructions for manufactured materials and products. Include manufacturer's certifications and laboratory test reports

as required, including signed and sealed structural calculations by a professional engineer in the State of Arizona or the state of work.

2. Shop Drawings shall include:
   a. Complete information for fabrication and installation of the prefabricated building including but not limited to critical dimensions, jointing and connections, fasteners and anchors.
   b. Materials of construction.
   c. Sizes, spacing, and location of structural members, connections, attachments, openings and fasteners.
   d. Interior and exterior finish options and paint color options.
   e. Drawings shall be signed and sealed by a professional engineer in the state of Arizona.
3. Samples: 8-inch square sample of representative wall construction, upon request.
4. Manufacturer's installation instructions.
5. Concrete Compression Test Reports: Submit written reports of Concrete Compression Test results for approval prior to shipment (only for prefabricated concrete building).

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The Prefabricated Building manufacturer shall exhibit satisfactory performance under service conditions of an equal magnitude for a period of not less than 5 years.
   1. Codes and Standards: Comply with provisions of the following building codes, specifications, and standards, except as otherwise indicated:
      a. 2018 International Building Code.
      b. 2017 National Electrical Code.
      c. 2018 International Plumbing Code.
      d. 2018 International Fire Code.
   2. Pre-installation Conference: Ensure that Site preparation is adequate, verify load bearing capabilities, elevation and level of substrate to accept the Prefabricated Building.

1.06 WARRANTY

A. The Prefabricated Building Supplier shall provide material and workmanship warranty that includes 10 years for all exterior surfaces, all structural members, roofing and all other components. The warranty shall include all components that are supplied by the Prefabricated Building Supplier.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver Prefabricated Buildings to the Project Sites, as shown on the Drawings in Aneth and Montezuma Creek, Utah, in such quantities and at such times to ensure continuity of installation.

B. Deliver units free of cracking, distortion, staining, or other physical damage.

C. Store products in weather protected areas (if required) until installation. Protect from construction traffic and damage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products shall be the following or pre-approved equal:
   1. Prefabricated Concrete Buildings:
      a. Oldcastle Precast
      b. Jensen Precast
      c. United Concrete
      d. Approved Equal.

2.02 MATERIALS

A. The prefabricated concrete building shall be constructed of reinforced concrete, 4,000 psi minimum compressive strength at 28 days and reinforced with Grade 60 rebar.
   1. The concrete mix design shall include 5% (±1%) air entrainment.
   2. Slump shall not exceed 4 inches.
   3. Mechanical vibration shall be employed for consolidation to eliminate voids and honeycombing.

B. Structural steel, embedment steel, and connections shall conform to ASTM A-36. All exposed steel plates and connections shall be painted with one field coat of compatible primer and one coat of epoxy paint.

C. Field welding shall be performed using E70XX electrodes and shall conform to the American Welding Society, Structural Welding Code.

D. The prefabricated concrete building shall be constructed to provide a minimum 1-1/2-hour fire-resistance rating.

E. The prefabricated concrete building walls shall have a smooth formed finish with a shop applied paint applied to the interior finishes. All doors, frames, and trim shall be painted. Refer to Division 9 Specifications.

F. The prefabricated building exterior shall be natural concrete finish.

G. Provide bearing pads for prefabricated concrete buildings.

H. Provide R-18 foam insulation rollup for all walls and roof.

PART 3 - EXECUTION

3.01 ERECTION

A. CONTRACTOR shall be responsible for location of the structure, orientation, bench marks, reference floor elevations, lines, and grades.

B. Coordinate and furnish setting drawings, diagrams, templates, instructions, and directions for site preparation. Install flexible bearing pads where required.

C. Set Prefabricated Buildings plumb, with proper alignment to other Site features, and secure into position.

END OF SECTION

SECTION 13201

CONE-BOTTOMED HIGH DENSITY CROSSLINK POLYETHYLENE (HDXLPE) TANKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish and install (HDXLPE) double containment chemical tanks and appurtenances as shown on the Drawings and as specified.

B. Related Sections include but are not limited to the following:
   1. Section 01340 - Technical Submittals
   2. Section 01600 - Product Delivery, Storage and Handling.
   3. Division 15: Applicable Sections on Piping and Installation, Pipe Supports, Fittings, Valves and Accessories.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of three years prior experience in construction of cone-bottomed crosslink polyethylene tanks in similar applications and shall be able to show evidence of previous installations in the past 36 months or provide a list of customers using tanks for the same application.

B. Source Quality Control:
   1. Each tank shall be inspected for defects in accordance with the requirements of ASTM D1998 (Standard Specification for Polyethylene Upright Storage Tanks).
   2. Hydrostatic Test of Each Tank at Factory:
      a. Each tank shall be factory tested by filling with water to overflow prior to being placed in service. Blind flange or plug all outlets as required for testing.
      b. All materials, labor and equipment for above tests and retests shall be furnished by CONTRACTOR. This will not, however, relieve CONTRACTOR from repairing leaks that may appear when the tanks are field tested. Upon arrival at the site, the tanks shall be retested with water. Any leaks shall be repaired immediately by CONTRACTOR and tanks shall be retested. Above procedure shall be repeated until tanks are 100 percent leak free.

C. Materials Testing:

1. The material employed in items fabricated of crosslink polyethylene shall be capable of withstanding maximum calculated stresses that may occur during fabrication, installation and continuous operation, with allowance for an adequate safety factor. To confirm materials properties, tests shall be conducted by an independent, qualified testing laboratory on representative material samples in accordance with specified reference standards.

D. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ANSI B16.5 - Valves and Fittings Package.
2. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
3. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
4. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
5. ASTM D883 - Standard Terminology Relating to Plastics.
6. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D1525 - Standard Test Method for Vicat Softening Temperature of Plastics.
8. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
9. ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tank: Section 11.3: Low Temperature Impact Test and Section 11.4: Oxylene-Insoluble Fraction (Gel Test).

E. Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the production of such items and have a successful history of product acceptability, as interpreted by ENGINEER.

F. Tanks shall be manufactured by a firm with a nationally accepted quality standard ISO 9001: 2015

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. CONTRACTOR shall submit as provided in this Section, shop drawings, details of construction and erection for each tank as listed below. Equipment will not be accepted and installation will not be allowed until such review has been completed:
    a. Dimensions of storage and secondary containment tanks, fittings and attachments, with bolt and gasket material.
    b. Details of inlet and molded outlet fittings, manways, flexible connections, and vents.

c. Wall thickness calculations per ASTM D 1998 using 300-psi design hoop stress @ 100 degrees F.
d. Locations of fittings and attachments and size of manway openings.
e. Resin used and a complete manufacturer specification of the resin used.
f. Empty weight of tanks.
g. Electrical heat tracing and panel, and installation details.
h. Insulation data.
i. Statement that fabrication is in accordance with these Specifications.
j. Certificate of Compliance from the tank manufacturer stating:
    1) All fittings, etc. have been installed by the tank manufacturer.
    2) Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.
    3) That materials and resin used are suitable for intended service.
    4) Details on packaging.
    5) Instructions for handling, storage and installation of tanks.
k. Detailed drawings showing dimensions of tank ladder, safety cage, circular SS handrail, and operator safety deck.

2. Submit a list of three previous installations in the past 36 months or provide a list of customers using tanks for the same chemical applications
3. Submit the supporting information of ISO 9001: 2015 certification.
4. Submit a factory test report showing material, wall thickness verification, fitting placement verification including molded in outlet, visual inspection, impact test, gel test and hydrostatic test.
5. Operation and Maintenance Manuals.

1.04 WARRANTY

A. The warranty shall be provided by the manufacturer for a period of one year from being placed into service.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. CONTRACTOR shall be responsible for the safe transportation to the job site, including any freight cost and necessary permits, handling, and open air storage of the tanks and other materials specified in this Section.

B. Tanks delivered to the job site shall be inspected by CONTRACTOR for damage, unloaded and stored with a minimum of handling. Comply with manufacturer's recommendations for handling and storing tanks. Tanks shall be shipped empty, all interior components shall be shipped separately.

C. In general, tanks shall be:
   1. Checked and tied down to prevent being blown by wind.
   2. Vented to allow for temperature changes that may affect their integrity.
      a. Provided with opening protection to exclude foreign matter.
   3. Large sub-assemblies should be supported during unloading to prevent excessive deflection and overstressing.
   4. Equipment and materials shall be stored so as to keep free from damages and deterioration.

D. Tanks shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any tanks in transportation.

E. Tanks shall be clearly marked for any precautions in handling and transportation.

F. Trip recorders shall be used when shipping large vessels by rail.

G. After manufacture and before shipping, MANUFACTURER shall check tanks against shop drawings to confirm tanks are correctly manufactured.

1.06 EQUIPMENT INSPECTION

A. Prior to field hydrotesting of any vessel, vessel shall be checked for, which will include but not be limited to, the following:
   1. Vessel size, dimensions and fabrication tolerances.
   2. Proper nozzle and appurtenance placement in accordance with fabrication drawings.
   3. Minimum design thicknesses.

B. Prior to final inspection, all surfaces shall be made clean by brushing, wiping, or with a compressed-air blast to remove all loose foreign materials.

C. CONTRACTOR shall inspect each piece of equipment upon arrival at construction site to inspect for damage incurred in transit. Any damage shall be immediately repaired by respective equipment fabricator's personnel (not a sales representative).

PART 2 PRODUCTS

2.01 GENERAL

A. CONTRACTOR shall use the manufacturer’s name and model or catalog number to establish the standard of quality and general configuration desired.

B. CONTRACTOR shall make sure that like items of materials, equipment are provided by the same manufacturer.

2.02 MATERIALS

A. Plastic:
   1. The tanks shall be molded from High Density Crosslink Polyethylene (HDXLPE).

B. Fillers and Pigments:
   1. The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent UV stabilizer and maximum of 0.60 percent. Pigments may be added as desired by the OWNER or as designated by the manufacturer, not to exceed 0.5 percent of dry blend.

2.03 CONE-BOTTOMED HIGH DENSITY CROSSLINK POLYETHYLENE TANKS

A. The cone-bottomed high density crosslink polyethylene tanks shall be designed for the following:

Location	Service	Number	Tank Dimensions	Tank Volume (gal)
Montezuma Creek (MC) Wells 1 and 2	Backwash Holding Tank	2	See Drawings	2,300
MC Well 3	Backwash Holding Tank	1	See Drawings	1,400

B. Acceptable Manufacturers:
   1. Polyprocessing Company
   2. Snyder Industries
   3. Or Approved equal

C. The cone-bottomed high-density crosslink polyethylene dual wall tanks shall be constructed by the rotational molding process.
   1. The tank color shall be natural crosslink color.

D. The nominal properties of the material are as follows based on molded parts:

Property	ASTM Specification	Value
Density	D1505	0.938-0.944 g/cc
ESCR Condition A 10% Igepal 100% Igepal	D1693	>1,000 hours
Tensile Strength Ultimate 2 in/min Type IV Spec	D638	2,830 psi
Elongation at Break 2 in/min.	D638	700 percent
Vicat Softening Temperature	D1525	248 degrees F
Heat Distortion Temperature	D648	150 degrees F 66 degrees C
Brittleness Temperature	D746	<-180 degrees F
Flexular Modulus	D790	86,780 psi

2.04 VERTICAL STORAGE TANKS

A. The tanks shall be vertical, cylindrical, cone bottom, dome top, and seamless in construction.

B. Tanks shall be rotationally-molded, high density crosslinked polyethylene resin that shall contain ultraviolet stabilizer.

C. Tanks shall be designed using a hoop stress no greater than 600 psi. The wall thickness for a given hoop stress is to be calculated in accordance with ASTM D1998.

D. The tanks shall be closed top tanks with the top head integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. Flat areas shall be provided for attachment of large fittings on the dome of the tank.

E. The conical bottom shall be integrally molded with the cylindrical wall. Knuckle radius shall be:

Tank Diameter, feet	Minimum Knuckle Radius, feet
less than or equal to 6	1
greater than 6	1-½

F. Tank colors shall be natural (unpigmented), black (compounded), or as specified by the ENGINEER with written agreement by the tank manufacturer.

G. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories. Tanks shall be marked to identify the manufacturer, date of manufacture and serial numbers must be permanently embossed into the tank.

H. Fittings:

1. Fitting shall be PVC, gasket shall be EPDM and bolt material shall be titanium or a material that is compatible with the product being stored. Threaded fittings shall use American Standard Pipe Threads.
2. Bolted One-Piece Sure Seal (B.O.S.S.) Double flange fittings shall be constructed of virgin polyethylene. Bolts will be welded to a common backing ring and encapsulated with polyethylene preventing fluid contact with the metal material. Flange will have one full face gasket to provide a sealing surface against the flange and tank surface. Bolt holes shall straddle the principal centerline of the tank.
3. Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 6-ft maximum intervals. Down pipes and fill pipes shall be PVC or material compatible with the liquid stored.
4. U-Vents: Each tank must be vented for the material and flow and withdrawal rates expected. Vents should comply with OSHA 1910.106(F)(iii)(2)(IV)(9). U-vents shall be sized by the tank manufacturer and be furnished with insect screen if required in accordance with the venting schedule.
5. All fittings on the 1/3 lower sidewall shall have 100% virgin PTFE Flexijoint expansion joint. Expansion joint to have a minimum of 3 convolutions, stainless steel limit cables and fiber reinforced plastic (FRP) composite flanges. Galvanized parts shall not be accepted.
6. Expansion joint to meet the following minimum performance requirements:
   a. Axial Compression $\geq$1.5"
   b. Axial Extension $\geq$0.625"
   c. Lateral Deflection $\geq$14°
   d. Torsional Rotation $\geq$4°

2.05 ACCESSORIES

A. Stand:

1. Painted carbon steel or stainless steel stand for cone-bottomed tank shall be provided. Stands shall be designed and certified by a structural engineer registered in the State of the tank installation. Design shall conform to the most recent edition of the IBC code for seismic and wind loads.

B. Ladder:
   1. Fiberglass access ladders shall be provided with the polyethylene storage tanks at locations as shown. Safety cages shall be added to the ladders as required, per OSHA.
   2. Ladders must be secured to the tank and secured to the concrete to allow for tank expansion/contraction due to temperature and loading changes. Use proper chemical resistant materials when anchoring to tank dome or sidewall.
   3. All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.

C. Operator Access Safety Deck:
   1. Provide structurally supported FRP safety deck to access top of tanks as shown on drawings.

D. Manways:
   1. The manways shall be 24-inch diameter or greater and equipped with an emergency pressure relief device with pressure relief at 6" water column to prevent over-pressurization.
   2. Gaskets shall be closed-cell, cross-linked polyethylene foam, Viton, or EPDM materials.

E. Side Wall Fittings:
   1. Outlet pipe shall have integrally molded type fitting. Universal ball dome fittings with flange adapters shall be used for fill, level sensor, and level switch connectors. Flexi-joint flexible connections shall be used as needed. Materials options for flange fittings are PVC. Gasket material options are Viton and EPDM. All bolts used must be encapsulated with a compatible elastomer. Bolt material can be 316 SS, Titanium or Hastelloy 316 SS.

F. Tank Connections:
   1. To the extent feasible, all fittings located on the side of the tank shall be integrally molded type.
   2. All nozzles located on the tank roof shall be self-aligning type.
   3. CONTRACTOR shall be responsible for all coordination ad costs between instrument supplier and tank supplier to ensure that flange openings are suitable and compatible for installation of level sensors and probes.

G. Seismic Restraint and Hold Down System:
   1. Metal components to be galvanized, stainless steel, or painted clips, edge softeners, and tension ring with stainless steel and clamps.

H. Ultrasonic Level Sensor and Transmitter
   1. Type: The ultrasonic level transmitter shall be of the non-contact type for continuous measurement and control of liquid and solid levels.
   2. Performance Requirements:

a. Level Setpoints: (to be determined by the Owner).
b. Electrode Tag Numbers per Drawings, SEE Division 16 and 17 for details.

2.06 SYSTEM DESCRIPTION

A. All openings shall be covered to prevent the entrance of dirt and debris during shipping.

B. Instructions shall be provided for unloading and installation of tanks. Provide lifting lugs as needed.

2.07 FACTORY TESTING

A. Material Testing
1. Perform gel and low temperature impact tests in accordance with ASTM D1998 on condition samples cut from each polyethylene storage tank.
2. Degree of crosslinking: use Method C of ASTM D1998, Section 11.4 to determine the ortho-xylene insoluble fraction of cross-linked polyethylene gel test. Samples shall test at no less than 60 percent.

B. Tank Testing
1. Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D1998. Fitting placement tolerance shall be +/-½-inch vertical and +/-1 degree radial.
2. Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking, and delamination.
3. Hydrostatic test: Following fabrication, the bottom tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the top sidewall for a minimum of ½ an hour and inspected for leaks. Following successful testing, the tank shall be emptied and cleaned prior to shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the high-density crosslink polyethylene tanks in accordance with the Drawings and the manufacturer's instructions.

B. All fittings shall be installed and, if necessary, removed for shipping and shipped separately unless otherwise noted by the CONTRACTOR.

C. The CONTRACTOR shall make all piping connections to tanks as shown on the Drawings. These connections along with the storage tank connections must be tested with water after installation and prior to chemical introduction.

D. Tanks and support members shall be clamped using 1/4" 304 SS cable and clamps to loop around the grating of the bars to secure the tank into their final position according to the manufacturer's recommendations. See Drawings.

E. Provide SS clamps cable, nuts, and supports. Installation will be inspected by manufacturer to verify system flexible connections, venting and fittings are properly installed. In addition to on-sight inspection tank system(s) to be reviewed using tank manual check list as supplied by manufacture as listed below.

F. Manufacturer to provide 1 hour training session to prepare operators to service and maintain the tank system. Included in training session will be training manuals for the City's operation staff.

G. Manufacturer's trained technician to do an onsite inspection of installation. Inspection will verify chemical application, plumbing connections, venting, and applicable ancillary equipment such as ladders, restraints, etc. A verification of proper installation certificate will be supplied when equipment passes installation checklist.

H. Tank manuals will consist of installation check lists, tank drawing(s) as built, fitting drawings referencing nozzle schedule on tank drawing, materials of construction, and recommended maintenance program.

3.02 FIELD TESTING

A. After installation, each tank(s) connecting plumbing shall be field tested by filling with water. The tank and fittings shall hold water without loss or evidence of weeping for a period of 24 hours prior to acceptance.

B. After testing, the tanks shall be thoroughly cleaned.

C. Should any defects become evident during inspection, testing or within the guarantee period, the CONTRACTOR in conjunction with the tank manufacturer shall repair or replace the defective items as approved by the ENGINEER.

END OF SECTION

SECTION 13221

SUPPORT MEDIA

PART 1 GENERAL

1.01 SUMMARY

A. Packaged Filtration System (PFS) Supplier shall furnish and install support media for treatment vessels.

B. Related Sections: Include but are not necessarily limited to:
   1. Section 01340 - Technical Submittals
   2. Section 11406 - Packaged Filtration System
   3. Section 11407 - Treatment Vessels and Media Installation.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 136 - Method for Sieve Analysis of Fine and Course Aggregates.

B. National Sanitation Foundation Standard 61

C. Submittals:
   1. NSF Certification that the media approved for potable water use prior to issuance of final purchase order from PFS Supplier.
   2. One representative media sample prior to shipment.

PART 2 PRODUCTS

2.01 MATERIAL SPECIFICATIONS

A. Media physical parameters
   1. Unit weight (bulk density): 100 lbs/ft^3
   2. Three Gradations:
      5" depth of #8 x #12 Garnet on bottom
      5" depth of #25 Garnet in the middle
      5" depth of #32 Garnet on the top

B. Performance parameters:
   1. Backwash flow rate: 10 - 15 gpm/ft^2.
   2. Backwash bed expansion: none at the specified backwash rate.
   3. Service flow rate: 8 gpm/ft^2.

C. The garnet shall be free from clay, loam, dirt, calcareous, or other foreign material and shall consist of round or angular particles being relatively free of flat or elongated particles. The garnet shall be shipped bagged and palletized.

PART 3 EXECUTION

3.01 ACCEPTANCE AND TESTING

A. Media will be shipped by supplier to job site in 50 lb bags or other acceptable methods to ensure integrity of media.

B. Prior to media shipment, provide one representative media sample (1 lb) to ENGINEER for evaluation.

C. Upon media delivery at the site and before final payment , ENGINEER will conduct sieve analysis on media. The test will be performed within one week after sample shipment has arrived on site. The purpose of this test is to verify compliance with specifications. Media shipment will only be accepted, if sieve analysis results are satisfactory.

3.02 INSTALLATION

A. Place 3-feet of standing water in vessels prior to loading support media. Support media shall be placed in layers. Support media will be rinsed (in backwash mode) to remove fines after initial placement under the direction of the ENGINEER.

END OF SECTION

SECTION 13334

MAGNETIC FLOW METERS

PART 1 GENERAL

1.01 SUMMARY OF SECTION

A. Provide magnetic flowmeters as shown on the Drawings and schedule specified in this section.

B. Related Sections include, but are not necessarily limited to:
1. Division 1 - General Requirements.
2. Section 01340 - Technical Submittals.
3. Section 01600 - Product Delivery, Storage, and Handling.
4. Section 01715 - Equipment Operation and Maintenance Instructions.
5. Section 11005 - Equipment: General.
6. Division 16 - Electrical.

1.02 REFERENCES

A. National Electrical Manufacturer's Association (NEMA).

B. ICS 6, Enclosures for Industrial Controls and Systems.

1.03 SUBMITTALS

A. Shop Drawings:
1. Product data sheets, including dimensions and material specifications.
2. Documentation to demonstrate compliance with specifications.
3. Manufacturers installation instructions.
4. Flow ranges and levels of accuracy.
5. Electrical power requirements and wiring diagrams.
6. Provide manufacturer's certification that meter operates within specified ranges of accuracy for the given lengths of straight pipe runs upstream and downstream of flow meter.

B. Operations and Maintenance Manuals:
1. See Section 11005 - Equipment, General Statement.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Endress Hauser ProMag 53W.

B. ABB WaterMaster

C. Or pre-approved equal.

2.02 MATERIALS

A. Body: Carbon Steel.

B. Liner: Polyurethane.

C. Electrodes: Stainless steel.

2.02 DESIGN/FABRICATION

A. Provide integral flow transmitter mounted with NEMA 4 enclosure. Provide appropriate cable length. CONTRACTOR to coordinate with equipment supplier.

B. Solid state circuitry with adjustable span, zero and output signal damping.

C. Power Supply: Transmitter shall operate on 120 Vac, 60 Hz.

D. Flow Rate Ranges: Units shall operate under flow conditions specified in Meter Schedule with an accuracy of ±0.5% under all conditions.

E. Outputs: Provide with amplifiers, noise suppression circuitry, signal converting circuitry to produce an isolated 4-20 mA flow signal, fail alarm, empty pipe alarm, and a totalizer pulse signal transmitted to the main control panel.

F. Include LCD display calibrated for instantaneous and totalized display.

G. Flanged end connections rated for 150 psi; Flow meter body rated for 150 psi.

H. Accessories:
   1. Provide all ancillary devices required for a complete installation including grounding rings, signal isolators, cables, and hardware.

PART 3 EXECUTION

A. Installation: As per Drawings and manufacturer's installation instructions.

B. Project Conditions:
   1. Environmental Requirements: The instrument selected shall be suitable for the following conditions:
      a. Humidity: 0–50% relative humidity.
      b. Ambient temperature limit: 15 to 100 °F.

C. Manufacturer's Representative shall conduct checkout of equipment installation and provide four hours of training.

END OF SECTION

DIVISION 15

MECHANICAL

SECTION 15050

BASIC PROCESS PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. A 106 - Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
   2. A536 - Standard Specification for Ductile Iron Castings.
   3. D 2240 - Standard Test Method for Rubber Property - Durometer Hardness.

B. National Sanitation Foundation (NSF) 61.

C. AWWA C-111 - Standard for Rubber Gasketed Joints for Ductile Iron Pressure Pipe and Fittings.

D. Refer to Section 09800 for coating requirements for exterior of exterior piping.

1.03 DEFINITIONS

A. Exposed Piping: Piping within buildings, vaults, tunnels, or other structures without regard to elevation of piping, or exposed piping outside buildings and structures.

B. Buried Piping: Piping actually buried in soil or cast in concrete.

C. Wet Wall: Wall with water on at least one side.

1.04 INTENT OF DRAWINGS AND SPECIFICATIONS

A. Except in details, piping is indicated diagrammatically. Sizes and locations are indicated on the Drawings. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings.

B. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed:
   1. Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Time.

1.05 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Restraining Piping:
   a. Restrain piping as follows:
      1) When piping is underground, use mechanical restraints throughout. All buried piping shall be restrained.
      2) When piping is aboveground or under water, use mechanical or structural restraints.
   b. Provide restraints with ample size to withstand thrust forces resulting from test pressures.
2. Connections to Existing Piping:
   a. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
      1) Protect domestic water supplies from contamination:
         (i) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         (ii) Provide devices approved by owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
   b. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   c. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
3. Connections to In-Service Piping:
   a. Shutdown in-service piping in accordance with Section 01040:
      1) Establish procedures and timing in co-ordination with ENGINEER and OWNER of the in-service piping.
4. Connections of Dissimilar Metals:
   a. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   b. Nonferrous metals include aluminum, copper, and copper alloys.
   c. For flanged piping with dissimilar metals, use an insulated coupling or insulating gasket.
5. All pipe tapping saddles are to be of bronze construction, unless noted otherwise on the Drawings.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

A. Manufacturers: One of the following or pre-approved equal:
   1. Dearborn Brass Company, Model Number 5358.
   2. Keeney Manufacturing Company, Model Number 102 or Number 105.

B. Material: Chrome plated steel plate.

2.02 LINK SEAL

A. Manufacturers: One of the following or pre-approved equal:
   1. Calpico, Inc.
   2. Garlock Pipeline Technologies

B. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shapes to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a stainless steel pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.
   4. The link seals used in the chemical storage containment areas shall be corrosion resistant to the chemicals contained in the chemical storage tanks.

2.03 COUPLINGS

A. Ductile Iron Couplings:
   1. Provide ductile iron couplings for use in connection of smooth end joints of ductile iron, steel or other types of pipe.
   2. General Requirements.
      a. Sleeve or center rings shall be of nominal O.D. size, range and length specified. Sleeve shall be of Ductile Iron ASTM A536. Ends shall have a smooth inside taper to provide uniform gasket seal. Sleeve shall be given a shop coat of oil-modified urethane, corrosion-resistant paint.
      b. Follower flanges or end rings shall be of the thickness determined by the coupling size, and shall be of ductile iron, ASTM-536. Flanges shall be identified by a color coded shop coat finish as described in Item 2a.
      c. Gaskets shall be compression-type, formed with Virgin Styrene Butadiene Rubber (SBR), compounded with ingredients to produce

permanence and resistance to set after installation. O.D. range shall be imprinted on the gasket in permanent ink (minimum).

d. Bolts and nuts shall be of high-strength, low-alloy steel, with nominal coarse thread, and hex nuts with black finish. Dimensions and minimum stress values shall be in accordance with AWWA/ANSIC111/A21.11.

e. Where specification states a cast transition or reducing coupling in place of a straight coupling, the sleeve and follower flange shall be of the same manufacturer and compatible for the specific use intended.

f. Quality control procedures shall be employed to ensure that the sleeve, follower flanges, and gaskets are properly fabricated and free of any visible defects. Coupling shall have pressure rating of 150 psi.

3. Manufacture: EBAA Iron Inc., Romac Industries Inc., or Pre-approved equal.

B. Expansion Joint (Flexible Bellows Coupling):

1. Manufacturer:General Rubber or Pre-approved equal.

2. Performance and Design:

a. Provide single and double arch expansion joints, as shown on the drawings, complete with restraining rods to prevent over-expansion. Provide flanged spool with single or multiple arches, designed to provide motion capability as specified. Rubber expansion joints shall be rated for 250°F and 150 psi.

3. Materials:

a. Tube - Provide single, seamless, leakproof tube made of synthetic rubber that extends through the bore to the outside edges of both flanges.

b. Body - Fabric reinforcement shall be used as the flexible and supporting member between the tube and the cover. Fabrics of high strength synthetic fibers shall be used. All Fabrics plies shall be impregnated with rubber or synthetic compounds to permit flexibility between the fabric plies to reduce service strain.

c. Cover - The exterior surface of the joint shall be formed from synthetic rubber to protect the body from outside damage. Utilize special polymers to resist sunlight.

d. Integral Flanges - Constructed of resilient rubber, and smooth finish, the full-faced flanges form a tight seal against the pipe flange without the need of gaskets. Provide standard AWWA flanges as specified in Section 15062.

e. Provide restraining rods attached to flanges for thrust protection.

4. Execution:

a. Install expansion joint as shown on the Drawings and in accordance with the manufacturer's recommendations.

C. Flanged Coupling Adapter:
   1. Description: One end of adapter shall be flanged and the other end shall have a sleeve type flexible coupling.
   2. Pressure and Service: Same as connected piping.
   3. Material: Cast iron or steel.
   4. Bolts and Nuts: Type 316 stainless steel.
   5. Harnessing:
      a. Harness adapters to restrain pressure piping. Test pressures for pressure pipelines shall conform to the requirements of Section 15050, Piping Systems.
      b. For adapters 12-inch diameter and less, provide 1/2-inch minimum stainless steel anchor studs installed in a pressure tight anchor boss. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by manufacturer; however, the following minimum anchor studs shall be provided, unless otherwise approved by ENGINEER:
         1) 6-inch diameter and less: Two.
         2) 8-inch diameter and less: Four.
         3) 10-inch diameter and less: Six.
         4) 12-inch diameter and less: Eight.
      c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with a minimum of four Type 316 stainless steel bolts. Harness assembly shall be as designed and recommended by manufacturer. Dimensions, sizes spacings and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.
      d. Harness couplings to restrain pressure piping.
      e. Test pressures for pressure pipe lines shall conform to the requirements of Section 15050, Piping Systems.
      f. Harnessing shall conform to the details shown on the Drawings.
   6. Product and Manufacturer: Provide one of the following:
      a. Smith-Blaire, Model 912.
      b. Romac Industries Inc., FC400/FCA501/RFCA.
      c. The Ford Meter Box Company, Inc., FFCA.

2.04 CONTROLLED LOW STRENGTH MATERIAL

A. Controlled low strength material shall consist of portland cement coarse and fine aggregate, and water.

B. Cement content shall be 0.5 sack of cement per yard.

C. The material shall have slump of 7 inches ± dye inch.

D. Compressive strength at 28 days shall be 70 psi ± 30 psi.

2.05 BURIED PIPING

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:
   1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions which may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
   2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
   3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 WALL AND SLAB PENETRATIONS

A. Provide sleeves for piping penetrations through masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.

B. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping:
   1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
   2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
   3. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
   4. Seal spaces between pipes and sleeves.

C. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, reinforced concrete, and vitrified clay through structures:
   1. Provide couplings or wall pieces with mechanical push-ons, or similar flexible joints at outside of walls.
   2. Provide additional similar joints in piping at transition points between trenches and structure excavations.
   3. For steel piping, single joints may be used in lieu of two joints. Locate single joints outside within 2 feet from outside faces of walls.

D. Link Seal: Use 2 link seals where seal is used to seal at wet wall sleeves. Mount one seal on the inside face of the wall and the other on the outside face of the wall.

Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing.

E. Where not indicated on the Drawings, penetrations for conditions other than those specified under the preceding subparagraphs shall be one of the three types specified in such subparagraphs found by OWNER to be the most suitable for the particular conditions.

3.03 EXPOSED PIPING

A. Install exposed piping in straight runs parallel to the axes of structures, unless indicated otherwise:
   1. Install piping runs plumb and level, unless otherwise indicated on the Drawings.

B. Install exposed piping after installing equipment and after piping and fitting locations have been determined.

C. Support piping in accordance with Section 15141 and as shown on Drawings:
   1. Do not transfer pipe loads and strain to equipment.

D. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.

E. Assemble piping without distortion or stresses caused by misalignment:
   1. Match and properly orient flanges, unions, flexible couplings, and other connections.
   2. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
   3. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
   4. After piping assembly to fit when proper fit is not obtained.
   5. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

3.04 BURIED PIPING

A. Bury piping with minimum 4 foot cover without air traps, unless otherwise indicated on the Drawings.

B. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.

C. Laying Piping:
   1. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
   2. Place piping with top or bottom markings with markings in proper position.
   3. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
   4. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
   5. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

3.05 CLEANING

A. Piping Cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.
   2. Maintain pipe in clean condition during installation.
   3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
   4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
   5. At completion of work and prior to final acceptance, thoroughly clean work installed under these Specifications. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
   6. Clean chlorine piping by pulling a cloth saturated with trichloroethylene or other suitable chlorinated solvent through each length of pipe. Disassemble valves and clean with suitable solvent. All surfaces which may come in contact with chlorine shall be thoroughly dry, and free of oil or grease before placing in service.

B. Cleaning Potable Water Piping:
   1. Flush and disinfect potable water piping in accordance with Section 15495.

3.06 FIELD QUALITY AND CONTROL

A. General:
   1. Upon completion of piping, but prior to application of insulation on exposed piping or covering concealed/buried piping, test all piping systems.
   2. Test all piping systems at 150 psi for 2 hours, unless otherwise indicated. Pressure shall stabilize within 2% of 150 psi.
   3. Isolate equipment which may be damaged by the specified pressure test conditions.
   4. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge's range. Notify the OWNER 24 hrs prior to each test.
   5. Unless otherwise specified, completely assemble and test new piping systems prior to connection to existing pipe systems.
   6. Acknowledge satisfactory performance of tests and inspections in writing to OWNER prior to final acceptance.
   7. Provide all necessary equipment and perform all work required in connection with the tests and inspections.
   8. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.
   9. CONTRACTOR to dispose of testing water.

B. Pressure Testing Methods and Criteria:
   1. Types of pressure testing and inspection to be employed include hydrostatic pressure testing, and hydrostatic infiltration/exfiltration testing.
   2. Liquid systems:
      a. The following liquid piping systems shall have zero leakages at the specified test pressure throughout the specified duration:
         (i) Exposed piping.
         (ii) Buried insulated piping and buried or exposed pressure piping.
   3. Hydrostatic pressure testing:
      a. All joints, including welds, are to be left exposed for examination during the test.
      b. Provide temporary restraints for expansion joints for additional pressure load under test. Equipment in piping system with rated pressure lower than pipe test pressure shall be isolated by valves or blind flanges.
      c. Do not paint or insulate exposed piping until successful performance of pressure test.
      d. Test soil, waste and drain piping at completion of installation of each stack or section of piping by filling system with water to highest point and checking joints and fittings for leaks. Leaks must be eliminated before proceeding with work or concealing piping. Minimum test heights shall be 10 ft.

3.07 PIPING SCHEDULE

A. See Drawings.

END OF SECTION

SECTION 15063

COPPER PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies copper piping, tubing, couplings and fittings.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1. American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI) B16.22 - Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
2. ASME/ANSI B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. American Society for Testing and Materials (ASTM) B32 - Standard Specification for Solder Metal.
4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

PART 2 PRODUCTS

2.01 COPPER TUBING

A. Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn.

B. Provide Type K - Soft for buried piping and Type K - Hard for exposed piping.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

A. Unless otherwise specified, couplings and fittings for copper tubing 1/2-inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or pre-approved equal.

B. Couplings and fittings for copper tubing larger than 1/2-inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

A. Solder to be used in copper piping shall be ASTM B32, Alloy Grade 50B.

PART 3 EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS: All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS: Takedown couplings shall be screw union type.

C. DIELECTRIC PROTECTION: Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the CONTRACTOR shall provide dielectric protection.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

A. The installation, cleaning, disinfection, and testing of copper piping shall be in accordance with governing codes and authorities.

END OF SECTION

SECTION 15075

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. B 16.12 - Cast Iron Threaded Drainage Fittings.

B. American Society for Testing and Materials (ASTM):
   1. D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position.
   2. D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
   3. D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated by Poly (Vinyl Chloride) (CPVC) Compounds.
   4. D 1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   5. D 1869 - Standard Specification for Rubber Rings for Fiber Reinforced Cement Pipe.
   6. D 2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe.
   7. D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
   8. D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   9. D 2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   10. D 2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   11. D 2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   12. D 2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   13. D 2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
   14. D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic, Waste and Vent Pipe Fittings.
   15. D 2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.

16. D 2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
17. D 2855- 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.
18. D 3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
19. D 3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
20. D 3261 - Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
21. D 3350 - Specification for Polyethylene Plastic Pipe and Fittings Materials.
22. D 4101 - Specification for Polypropylene Injection and Extrusion Materials.
23. F 439 - Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
24. F 441 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
25. F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
26. F 483 - Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals.
27. F 493 - Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
28. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems.
29. F 679 - Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
30. F 714 - Specification for Polyethlene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
   1. C 900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In., for Water Transmission and Distribution.
   2. C 115 - Standard for Flanged Ductile Iron Pipe with Ductile Iron or Grey Iron Threaded Flanges.

D. Code of Federal Regulations:
   1. Title 49.

E. Plastic Pipe Institute (PPI):
   1. PE 3408.

F. United States Department of Transportation:
   1. Materials Transportation Bureau.

G. National Sanitation Foundation (NSF) 61.

1.03 ABBREVIATIONS

A. ABS: Acrylonitrile-Butadiene-Styrene.

B. CPVC: Chlorinated Polyvinyl Chloride.

C. DWV: Drain, waste, and vent.

D. ID: Inside diameter of piping or tubing.

E. NPS: Nominal pipe size followed by the size designation.

F. NS: Nominal size of piping or tubing.

G. PE: Polyethylene.

H. PP: Polypropylene.

I. PVC: Polyvinyl Chloride.

J. SDR: Standard dimension ratio.

1.04 SUBMITTALS

A. Product Data: Describe materials and installation equipment including fusion machine.

B. Manufacturer's Published Installation Instructions.

C. Certificates:
   1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting meet specified requirements.
   2. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.

D. Qualifications of installation crew for PE piping, including qualifications of the fusion machine technician.

1.05 QUALITY ASSURANCE

A. Fusion Machine Technician Qualifications: 1 year experience in the installation of similar PE piping systems from the same manufacturer.

B. Provide pipe and tubing bearing NSF seal, except for drainage piping.

C. Mark plastic pipe with nominal size, type, class, schedule or pressure rating, and manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle pipe and fittings as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except the DWV fittings need not be pressure rated.

C. Unions 2-1/2 inches and smaller: Socket end screwed unions. Make unions 3 inches and larger with flange ends with 1/8 inch full face soft rubber gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC schedule type piping: Designation PVC 1120 conforming to ASTM D 1785 and appendices thereto.
      a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D 1784.
      b. PVC Schedule Type Piping: Schedule 80 unless otherwise indicated on the Drawings.
   2. Fitting:
      a. Supplied by pipe manufacturer.
      b. Pressure Fittings: In accordance with ASTM D 2466 or ASTM D 2467.
      c. DWV Fittings: In accordance with ASTM D 2665.
   3. Solvent Cement: In accordance with ASTM D 2564.

2.03 PVC PIPING, CLASS TYPE

A. Materials:
   1. PVC pipe, Class type: Pipe shall have outside diameters of pipe sizes:

a. ASTM D2241 PVC Pipe, Pressure rating 250 psi: SDR 17 and Uni-Bell Standard UNI-B-2-72.
b. PVC Pipe, Class Type: AWWA C 900, Pressure Class 150 and SDR 18.
c. Bell Section: At least as strong as the pipe barrel.

2. Fittings: PVC pipes would be solvent welded together, unless shown otherwise.
3. Gaskets: Meeting the requirements of ASTM D 1869 or ASTM F 477.

2.04 PVC EXPANSION JOINTS

A. Materials:
1. PVC schedule type expansion joints: Designation PVC 1120 conforming to ASTM D 1785 and appendices thereto.
2. Seals: EPDM or Viton.

B. Manufacturers:
1. Spears.
2. Or Pre-approved equal.

C. PVC expansion joints shall be provided every 50 ft for pipe run.

2.05 PE AND HDPE PIPING FOR DRAIN, WATER, AND VENT

A. General:
1. Pipe and fittings: High density polyethylene.
2. Dimensions of pipe and fittings: Based on controlled outside diameter in accordance with ASTM F 714.
a. SDR: Equal to or less than 11.

B. Materials:
1. Manufacturers: One of the following or equal:
a. DuPont, Sclairpipe.
b. Polaris, Duratuff; or Pre-approved equal:
1) Pipe, fittings, and adapters: Furnished by the same manufacturer, and compatible with components in the same system and with components of other systems to which connected.
2. Polyethylene: In accordance with ASTM D 1248, Type III, Class C, Category 5, Grade P34; listed by the Plastic Pipe Institute under the designation PE 3408; and have a minimum cell classification, in accordance with ASTM D 3350, of 345434C.
a. Pipe and fittings: Manufactured from material with the same cell classification.

2.06 CPVC PIPE

A. CPVC pipe shall be Schedule 80, Class 23447-B, conforming to ASTM D 1784 and ASTM F 441.

B. All joints shall be solvent welded. At all valves, appurtenances and connections to equipment, CONTRACTOR shall provide unions for ease of disassembly. (THIS APPLIES TO ALL CPVC PIPING INSTALLED UNDER THIS PROJECT).

C. Provide flanged fittings at all valves and equipment with nitrile gaskets, unless shown otherwise on the Drawings. Provide type 316 stainless steel bolts and nuts.

D. Provide CVPC expansion joints for every 50 feet of pipe run. Confirm locations with ENGINEER in field.

2.07 SOURCE QUALITY CONTROL

A. PVC Piping, Schedule Type:
   1. Mark pipe and fittings in accordance with ASTM D 1785.

B. PVC Piping, Class Type:
   1. Test pipe to withstand, without failure, 150 psi, hydrostatic pressure.
   2. Test integral bell with the pipe.

C. CPVC Piping:
   1. Mark pipe and fittings in accordance with ASTM F 441.

2.08 DETECTABLE TAPE

A. Materials:
   1. 3.5 mil thick solid foil core encased in a protective plastic jacket.
   2. Resistant to alkalies, acids and other destructive elements commonly found in soil.
   3. Lamination shall have sufficient strength that the layers cannot be separated by hand.
   4. Total composite thickness shall be 4.3 mils minimum.
   5. Foil core to be visible to ensure continuity.
   6. Minimum tensile strength of 63 lbs in the machine direction and 68 lbs in the transverse direction per three (3) inch strip.
   7. Continuous warning message repeated every 16 to 36 inches shall be imprinted on the tape surface. Tape shall be colored.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
2. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
3. Provide serrated nipples for transition from plastic pipe to rubber hose.
4. All buried plastic pipe shall have detectable tape applied along the entire length of pipe.
5. PVC expansion joints installed on PVC pipelines as conditions require.

B. Installation of PVC Piping, Schedule Type:
1. Exposed 4-inch and larger connections will be van stone style flanged as shown on the drawings. Spigot van stone style will be used to flange fittings. Socket van stone style will be used for piping flanges exposed less than 4" and smaller connections will be solvent welded.
2. Neoprene gaskets will be used for all water piping.
3. Solvent weld joints in accordance with ASTM D 2855.
4. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC Piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C900 complemented with manufacturer's published instructions.
2. For contraction and expansion at each joint, provide rubber ring and integral thickened bell as part of each joint.
3. Direct burial installation tie-ins will be done at the proper buried temperatures.

D. Installation of Polyethylene (PE) Tubing and Fittings:
1. Install small bore PE tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.
2. Bundle tubing in groups of parallel tubes within protective sheath.
3. Tubes within protective sheath may be color coded, but protect tubing other than black outside the sheath by wrapping with black plastic electrician's tape.
4. Grade tubing connected to meters in one direction.

E. Installation of PE Piping for Drain, Waste, and Vent:
1. Install piping as recommended in manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Clean and test piping as specified in Section 15050.

END OF SECTION

SECTION 15110

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic requirement for valves:
   1. Requirements indicated on the Drawings and specified elsewhere in these Specifications take precedence over the requirements specified under this Section.
   2. Furnish and install valves required for proper piping and equipment operation and maintenance, in addition to the valves indicated on the Drawings, and specified.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A48 - Standard Specification for Gray Iron Castings.
   3. A536 - Standard Specification for Ductile Iron Castings.

B. American Water Works Association (AWWA):
   1. C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
   2. C504 - Rubber Seated Butterfly Valves.
   3. C508 - Swing Check Valves for Waterworks Service, 2 through 24 IN NPS.
   4. C110 - Standard for Ductile Iron and Grey Iron Fittings.
   5. C207 - Steel Pipe Flanges for Waterworks Service.

C. Steel Structures Painting Council (SSPC):
   1. SP-2 - Hand Tool Cleaning.
   2. SP-10 - Near-White Blast Cleaning.

D. American National Standards Institute (ANSI):
   1. B1.20.1, Pipe Threads, General Purpose.

E. NSF 61 - Drinking Water System Components.

1.03 DESIGN REQUIREMENTS

A. Pressure Rating: 150 psi.

B. Valve To Piping Connections:
   1. Valves 3 inch nominal size and larger: Flanged ends unless otherwise specified on the Drawings.
   2. Valves less than 3 inch nominal size: Screwed ends.

1.04 SUBMITTALS

A. Product Data: Submit detailed technical information relating to the valve including description of component parts, materials of construction, performance, dimensions, and weights.

B. Manufacturer's Published Instructions:
   1. Submit instructions for installation, operation, and maintenance of valves.
   2. Furnish bound sets of installation, operation, and maintenance instructions for each type of valve 3 inch nominal size and larger.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Valves: Manufactured by manufacturers whose valves have had successful operational experience in comparable service.

PART 2 PRODUCTS

2.01 MATERIALS

A. Underground Bolts: Low-alloy steel in accordance with AWWA C111.

B. Bronze And Brass Alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacturing of valve parts.

C. Interior Protective Coating:
   1. Epoxy coat interior non-working surfaces, except stainless steel surfaces.
   2. Coating Types:
      a. Powder Epoxies:
         1) Manufacturers: One of the following or equal:
            a) 3-M Company, ScotchKote 134; certified to NSF 61 for drinking water use.
            b) Or Pre-approved equal.
      b. High Solids Polyamine Cured Epoxy:
         1) Manufacturers: One of the following or equal:

a) Tnemec: Series N140 Pota Pox
b) Ameron: Amercoat 395
c) Carboline: Carboguard 891
d) Devoe Bar Rust 225
e) Or Pre-approved equal

3. Clean surfaces to meet SSPC-SP-10, near-white metal blast cleaning, with grit of size recommended by epoxy manufacturer.
4. Apply in accordance with manufacturer's published instructions:
   a. High Solids Polyamine Cured Epoxy:
      1) Not less than 2 coats to the specified thickness.
5. Coating Thickness: 12 mils except that:
   a. Coating thickness in grooves for gaskets: 5 mils.
   b. Do not coat seat grooves in valves with bonded seat.
6. Quality Control:
   a. Coating Thickness: Measured with a nondestructive magnetic type thickness gauge.
   b. Verify coating integrity with a holiday detector set at 1,800 volts.
   c. Consider tests successful when coating thickness meets specified requirements and when no pin holes are found:
      1) Correct defective coating disclosed by unsuccessful tests, and repeat test.
      2) Repair pinholes in accordance with manufacturer's published recommendations.

D. Underground Valves:
1. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.
2. Coating and Wrapping:
   a. Paint buried valves with 3 coats of asphalt varnish in accordance with AWWA C 504:
      1) Protect coating from damage during handling and installation; repair coating where damaged.

E. Valve Boxes:
1. Furnish and install access to operators of buried valves through cast-iron valve boxes, as shown on Drawings:
   a. Do not support boxes on valve, valve operator, or pipe.
   b. Boxes: Fabricated of cast-iron; provided with cover, asphalt varnished or enameled. Adjust to grade, install centered around the upper portions of the valve and valve operator.
   c. Use seamless pipe inside valve box. If seam is required, use a sealed bell joint.
   d. Minimum clear inside diameter of 6 inches.
   e. Install per MAG Detail 391-1 Type A.

F. Valve Operators:
   1. Open counterclockwise.
   2. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels.
   3. Provide manually operated valves and gates located not more than 6 feet above the operating level with levers, tee handles, wrenches, or handwheels, as shown on Drawings.
      a. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
      b. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.
   4. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels:
      a. Chains: Sufficient length to reach approximately 4 feet above the operating level.
      b. Where chains constitute a nuisance or hazard to operating personnel, provide hold-backs or other means for keeping the chains out of the way.

2.02 FABRICATION

A. Valves:
   1. End connections:
      a. Provide end connections for valves as required in Piping Schedule.
      b. Assure end connections meet the following standards:
         1) Threaded: ANSI B1.20.1
         2) Flanged: AWWA C207.
         3) Bell and spigot or mechanical (gland) type: AWWA C111.

PART 3 EXECUTION

3.01 PREPARATION

A. Once flanged valves and flanged check valves are selected, determine face-to-face dimensions of valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Prior to installation, valves that will be electrically actuated will have actuators mounted and tested by the valve manufacturer. Actuators will be shipped by the actuator manufacturer to the valve manufacturer for mounting and testing.

B. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

C. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by CONTRACTOR.
   2. Where such additional valves are required as a result of a substitution or change initiated by CONTRACTOR.
   3. Install valves with their stems in vertical position above the pipe, except as follows:
      a. Butterfly valves, gate valves aboveground, globe valves, and angle valves may be installed with their stems in the horizontal position.

D. Install valves so that handles clear obstructions when the valves are operated from full open to fully closed.

E. Place top of valve boxes flush with finish grade or as otherwise indicated on the Drawings.

3.03 ADJUSTING

A. Make sure all adjustments to valves, operators and appurtenant equipment prior to Project Acceptance. Operate valve, open/close, at system pressures.

END OF SECTION

SECTION 15111

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: DIP ball valves, plastic body ball valves and instrument isolation ball valves.

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B16.5 – Pipe Flanges and Flanged Fittings.

B. American Petroleum Institute (API).

C. American Society for Testing and Materials (ASTM):
   1. A 351 – Specification for Castings, Austenitic, for Pressure-Containing Parts.

D. American Water Works Association (AWWA):
   1. C 507 – Standard for Ball Valves 6 Inch Through 48 Inch.

E. National Sanitation Foundation (NSF) 61.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Plastic body ball valves on plastic pipelines.
   2. Where valves are connected to electric actuators, the valve and actuator assembly shall be supplied by the same Supplier/Manufacturer.

PART 2 PRODUCTS

2.01 BALL VALVE TYPES

A. Full Port PVC Ball Valves:
   1. Manufacturers: One of the following or equal.
      a. Apollo.
      b. Hayward
      c. Or pre-approved equal.

B. Plastic Ball Valves:
   1. Manufacturers: One of the following or equal.
      a. Asahi America.
      b. Spears.
      c. Hayward.
      d. Or pre-approved equal.

C. General:
   1. Type: Non-lubricated and capable of sealing in either flow direction.
   2. End Connections: for PVC valves - flanged or socket end connections, true union; for DI valves - flanged end connections.
   3. Operator Handle: Lever.
   4. Valves bodies requiring actuators shall have integrally mounted molded stem support and platform to assure proper alignment of the actuator to the valve.
   5. Valves shall be pressure rated for 150 psi.

D. Materials:
   1. Body: PVC/CPVC body for valves.
   2. Ball: PVC/CPVC for plastic valves.
   3. Seats: FKM (Viton) or EPDM or PTEF.
   4. O-rings: FKM (Viton) or EPDM.
   5. All ball valves installed on chemical system lines shall be made of CPVC/PVC as shown on Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Schedule: All valves 3-inches and smaller are not shown on the Valve Schedule in the Drawings.

END OF SECTION

SECTION 15114

CHECK VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: silent check valves, and plastic body ball check valves

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A 48 – Specification for Gray Iron Castings.
   2. A 126 – Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   3. A 276 – Specification for Stainless Steel Bars and Shapes.
   4. B 582 – Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet and Strip.
   5. B 584 – Specification for Copper Alloy Sand Castings for General Applications.

B. American Water Works Association (AWWA):
   1. C 508 – Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.

C. American Petroleum Institute (API).

D. National Sanitation Foundation (NSF) 61

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Check Valves: When not otherwise specified as indicated on the Drawings, provide check valves suitable for service as follows:
      a. In either horizontal or vertical position.
      b. Under pressures equal and less than 150 psig.
      c. Plastic body ball check valves on plastic pipelines.

PART 2 PRODUCTS

2.01 SILENT CHECK VALVES (METAL BODY)

A. Globe Style Silent Check Valves 3 Inches through 24 Inches:

1. Manufacturers: One of the following or equal:
   a. APCO
   b. Valmatic
   c. Clow
   d. Crispin
   e. Or pre-approved equal.
2. Valve Design:
   a. Globe
   b. Valve plug will be spring loaded, normally closed, by means of one or more stainless steel springs.
   c. Check valve must be capable of silent operation when installed in the vertical or horizontal position - flow up or down.
   d. Spring must be helical or conical. Seat and plug shall be hand replaceable in the field for ease of maintenance.
   e. The flow area through the body shall be equal to or greater than the cross sectional area of the equivalent pipe size.
3. Materials:
   a. Body: Cast-iron, ASTM A 126 Class B.
   b. Doors: Ductile iron ASTM A536.
   c. Hinge Pins: Stainless steel.
   d. Sealing element: Buna-N.
   e. End Connections: Flanged.

2.02 BALL CHECK VALVE (PLASTIC BODY)

A. Valves ¼ inch through 6 Inches:
1. Manufacturers: One of the following or equal:
   a. Asahi/America
   b. Spears Manufacturing Company
   c. Chemtrol Division, NIBCO, Inc.
   d. Or pre-approved equal
2. General:
   a. End Connection: True union; solvent or heat welded to piping.
3. Materials:
   a. Body: CPVC or PVC.
   b. Ball: CPVC or PVC.
   c. Seats: FKM (Viton) or EPDM
   d. O-rings: FKM (Viton) or EPDM
   e. All ball check valves installed on chemical system lines shall be made of CPVC or PVC.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install with proper orientation of flow direction arrow on valve body.

3.02 ADJUSTING

A. Adjust cushioned check valves in the field by means of external adjustment devices to minimize pressure surges.

B. Adjust weight on check valves to affect proper closing action on equipment shutdown.

END OF SECTION

SECTION 15141

MECHANICAL - PROCESS PIPE SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Supports for pipe, fittings, valves, and appurtenances.

1.02 REFERENCES

A. American National Standard Institute or Manufacturer's Standardization Society (ANSI/MSS):
   1. SP 58 - Pipe Hangers and Supports- Materials, Design, Manufacture, Selection, Application and Installation.
   2. SP 69 - Pipe Hangers and Supports, Selection and Applications.

1.03 SUBMITTALS

A. Shop Drawings: Include schedule, indicating where supports will be installed, and drawings of pipe support system components.

PART 2 PRODUCTS

2.01 PIPE SUPPORTS

A. Pipe Supports:
   1. 3-inch and larger: As indicated on the Drawings.
   2. 2-inch and smaller: Supplied by CONTRACTOR under constraints of these specifications. Locations for these supports are not specifically shown in drawings but are the responsibility of the CONTRACTOR.

2.02 MATERIALS

A. Materials: As indicated on the Drawings.

B. Materials Not Specifically Indicated on the drawings: Hot-dip galvanized steel with stainless fasteners.

PART 3 EXECUTION

3.01 INSTALLATION

A. Properly support, suspend or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, over-stressing, or movement of piping and to prevent thrusts or loads on or against connected pumps, valves, meters and other equipment.

B. Carefully determine locations of inserts. Anchor to form work prior to placing concrete.

C. Do not use stud type powder actuated fasteners for securing metallic conduit or steel pipe larger than 1 inch to concrete, masonry, or wood.

D. Suspend pipe hangers from hanger rods. Secured with double nuts.

E. Install continuously threaded hanger rods only where indicated on the Drawings.

F. Use adjustable ring hangers; or adjustable clevis hangers, for 6-inch and smaller diameter pipe.

G. Use adjustable clevis hangers for pipe larger than 6 inches in diameter.

H. Secure pipes with galvanized double nutted U-bolts or suspend pipes from hanger rods and hangers.

I. Support Spacing (unless otherwise specified on drawings):
   1. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
   2. Support larger than 2-inch piping on horizontal and vertical runs at maximum 8 feet on center, unless otherwise specified.
   3. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.
   4. Support tubing, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing at intervals close enough to prevent sagging greater than 1/4 inch between supports.

J. Install Supports at the following Locations (unless otherwise shown on Drawings):
   1. Horizontal bends.
   2. Both sides of flexible pipe connections.
   3. Base of risers.
   4. Floor penetrations.
   5. Connections to pumps, blowers and other equipment.
   6. Valves and appurtenances.

K. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

L. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

M. Size hanger rods, supports, clamps, anchors, brackets, and guides in accordance with ANSI/MSS SP 58 and SP 69.

N. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

O. Support plumbing drainage and vents in accordance with Uniform Plumbing Code.

P. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plates, copper throughout, or isolated with neoprene or PVC tape.

Q. Where pipe is insulated, install over-sized supports and hangers.

R. Install insulation shield in accordance with ANSI/MSS SP 69, Type 40. Shield shall be galvanized steel unless specified elsewhere.

S. Install riser clamps at floor penetrations and where indicated on the Drawings.

T. Paint or Coat support system components as specified in Section 09800.

END OF SECTION

SECTION 15495

DISINFECTION OF PROCESS WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Disinfection of water lines and piping, bacteriological testing, and flushing at lines at completion of construction. This includes piping at water treatment facility site.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. AWWA C 651 - Disinfecting Water Mains.

B. Standard Methods for Examination of Water and Wastewater.

1.03 SUBMITTALS

A. Submit disinfection test plan which details procedure to be utilized to disinfect water lines including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of flushing and location of flushing ports.
   4. Method of dechlorination.
   5. Disposal location for dechlorinated water.

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Treatment subcontractor's name, address, and phone number.
   4. Type and form of disinfectant used.
   5. Time and date of disinfectant injection start.
   6. Time and date of disinfectant injection completion.
   7. Test locations.
   8. Initial and 24-hour disinfectant residuals in part per million for each outlet tested.
   9. Time and date of flushing start.
   10. Time and date of flushing completion.
   11. Disinfectant residual after flushing in parts per million for each outlet tested.

C. OWNER will perform sampling and laboratory analyses for microbiological testing.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry with temperatures as uniform as possible between 60 and 80 degrees Fahrenheit.

1.05 PROTECTION

A. Provide necessary signs, barricades, and notices to prevent persons from accidentally delivering water for potable use.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disinfectant: Free chlorine in liquid form.

PART 3 EXECUTION

3.01 CLEANING WATER LINES

A. Prior to chlorination, remove by flushing or other means, soil, and debris from water lines.

3.02 INSPECTION

A. Verify that water line system is completed and cleaned.

B. Start disinfection of water lines when conditions are satisfactory.

3.03 SYSTEM TREATMENT

A. Perform disinfection of water lines in accordance with AWWA C 651 and as specified in this Section.

B. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.

C. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:

1. Ends of piping runs.
2. Remote outlets.

D. Maintain disinfectant in system for 24 hours.

E. When disinfectant residual is less than 25 parts per million after 24 hours, repeat system treatment.

3.04 FLUSHING

A. Remove disinfectant from water lines.

B. Flush water lines with potable water containing no more disinfectant residual than the active distribution system or 1.0 parts per million, which ever is greater.

C. Continue flushing until water at designated flushing ports contains disinfectant residual equal to concentrate specified above.

3.05 DISPOSAL OF CHLORINATED WATER

A. For on-site piping, dechlorinate and dispose water into backwash holding tank (on site).

3.06 MICROBIOLOGICAL TEST

A. Advise OWNER to take water samples no sooner than 24 hours after flushing system.

B. At the end of 24 hours and before the water main is placed in service, collect microbiological samples in accordance with the submitted disinfection test plan at each piping run.

C. When microbiological test proves water quality to be unacceptable, repeat disinfection treatment.

END OF SECTION

SECTION 15496

DISINFECTION OF TREATMENT VESSELS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Disinfection of the new treatment vessel (pressure vessel), bacteriological testing, flushing and disposal of disinfecting water at completion of treatment.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. AWWA C 653-97 - Standard for Disinfection of Water Treatment Plants

B. Standard Methods for Examination for Water and Wastewater.

C. OSHA Confined Space Requirements
   1. 29 CFR Part 1910.146

1.03 SUBMITTALS

A. Submit disinfection test plan which details procedure to be utilized to disinfect the adsorption contactor including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of dechlorination.
   4. Disposal location for dechlorinated water.
   5. MSDS for each chemical to be used.

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Type and form of disinfectant used.
   4. Time and date of disinfection start.
   5. Time and date of disinfection completion.
   6. Test locations.
   7. Initial and 24-hour disinfectant residuals in part per million for each outlet tested (Engineer may perform sampling and analysis, if desired).
   8. Time and date of flushing start.
   9. Time and date of flushing completion.
   10. Disinfectant residual after flushing in parts per million for each outlet tested.

11. OWNER will perform sampling and analysis. Coordinate microbiological testing with Engineer. OWNER to collect samples for microbiological testing - OWNER to perform all laboratory analyses.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 degrees Fahrenheit and 80 degrees Fahrenheit.

1.05 PROTECTION

A. Comply with all applicable regulations, including but not limited to OSHA and COP Combined Space Entry SOP.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disinfectant: Sodium hypochlorite in liquid form conforming to ANSI/AWWA B300.

PART 3 EXECUTION

3.01 CLEANING VESSELS

A. Prior to chlorination, remove by flushing or other means, soil, and debris from adsorption vessels.

B. Wash Garnet support media, prior to loading, to eliminate fines. Install support media prior to disinfection.

C. DO NOT INSTALL IX RESIN PRIOR TO DISINFECTION OF VESSEL. IX MEDIA WILL FOUL IF DISINFECTION IS PERFORMED WITH MEDIA IN VESSELS. IX resin will be installed after the vessels have been disinfected successfully.

3.02 INSPECTION

A. Verify that vessels are completed and cleaned.

B. Start disinfection of vessels when conditions are satisfactory.

3.03 SYSTEM TREATMENT

A. METHOD: Perform disinfection of the adsorption vessel in accordance with AWWA C 653-97 Sec. 4.4.1 and as specified in this Section.
   1. The adsorption vessel shall be filled to the overflow level with potable water to which enough chlorine is added to provide a free chlorine residual in the full facility of not less than 15 mg/L at the end of the appropriate 12-hour period. The Chlorine, Sodium Hypochlorite, shall be introduced into the water as described in section 3.03B.

B. APPLICATION: Sodium Hypochlorite shall be poured into the adsorption vessel, manually, and allow the flowing water provide the mixing. The filling of the adsorption vessel shall begin as soon as cleaning of the vessel is completed. See Section 3.01. The Sodium Hypochlorite shall be poured through the roof manhole. The Sodium Hypochlorite shall be poured into the water in the adsorption vessel when the water is not more than 3 ft (0.9m) in depth, nor less than 1 ft (0.3m) in depth, followed by filling each vessel until water flow is detected in the vent line. The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping, and shall be applied to any separate drain piping such that it will have available chlorine of not less than 15 mg/L when filled with water.

C. RETENTION: The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 24 hours, after which each vessel will be drained of the 10 mg/L chlorinated water. Bacteriological sampling of the vessel effluent should be performed after the disinfection procedure is complete. Conduct bacteriological testing in accordance with sub-section 3.05.

D. Drain or pump chlorinated water into the Backwash Holding Tank.

E. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:
   1. IX Vessel outlets.

3.04 DISPOSAL OF CHLORINATED WATER

A. Dechlorinate water in the backwash holding tank in accordance with AWWA C653-97 prior to disposal.
B. Apply and mix Sodium Bisulfite to the Backwash Holding Tank before discharging test water on site.

3.05 BACTERIOLOGICAL TEST

A. After the chlorination procedure is completed, and before the adsorption vessel is placed in service, water from the adsorption vessel will be sampled and tested for

coliform organisms in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater.

B. At the end of 24 hours and before the water main is placed in service, the OWNER will collect bacteriological quality samples at adsorption vessel outlets in accordance with the submitted disinfection test plan and Standard Methods for the Examination of Water and Wastewater.

C. OWNER will arrange for and pay cost to analyze water samples in accordance with Standard Methods of Water and Wastewater.

D. When bacteriological test proves water quality to be unacceptable, repeat disinfection treatment.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Electrical general provisions as indicated, specified and required for constructing a complete, ready for use electrical system as described in these Contract Documents.

B. Labor, materials, apparatus, and appliances essential to the complete functioning of systems described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, Contractor shall refer to the Engineer for supplemental instructions.

C. All items not specifically mentioned in these Specifications or noted on the Drawings, or on shop drawings, but which are necessary to make a complete and satisfactory, working electrical/instrumentation installation, shall be deemed to be included herein.

D. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of -20°C to 50°C, and specifically rated for an altitude of 4500 feet. Where these criteria cannot be met, ancillary equipment and/or special derating factors as approved by the Engineer shall be utilized.

E. The Contractor shall perform all necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, etc as required for the proper installation of conduits whether inside or outside of the building(s) and structure(s). The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.

1.02 SUBMITTALS

A. Submit documentation for review as described in individual Specification Sections for products requiring submission.

B. Submit Division 16 in one submittal, or at a maximum, the following may be submitted as separate submittals for this project.

1. Commodities (Sections 16010-16195) and Grounding (Section 16450)
2. Mini-Power Centers (Section 16480) and Motor Controllers (Section 16481)
3. Lighting (Section 16500)

C. Documentation must be arranged in numerical sequence corresponding with each Specification Section and article of each Section. Soft copies shall be in “pdf”

format with "character recognition" and shall include the following as a minimum:

1. A cover page to identify the Contractor's name, name of the project, date and description, i.e. "Division 16 – Commodities".
2. An index corresponding to each specification section with all addendum updates included. Each paragraph or bulleted item shall be check marked to signify compliance with each item and the information is included in the submittal package. If full compliance is not met for any reason, the non-compliance item shall be underlined and reference to a detailed written explanation of the deviation or non-compliance shall be provided for consideration.
3. Bookmarks within each section for each major component within.
4. Complete manufacturer name and model number of each item. Listing items "as specified" without both make and model or type designation is not acceptable.
5. Descriptive Data: complete description, information, and performance data covering materials and equipment that are being proposed. Each component shall be clearly identified on each sheet. Refer to individual specification sections for additional submittal requirements.

D. Hard copies shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and submittal number.

E. Important Notice:

1. If Contractor's submittal departs from the Contract Documents, the Contractor shall make specific mention thereof on the submittal, otherwise review of such submittal by the Engineer shall not constitute review of such departure(s).
2. The Engineer's submittal review is for the sole purpose of verifying general conformance with design intent and general compliance with Contract Documents. Approval of a submittal by the Engineer does not relieve the contractor of responsibility for correcting errors which may exist in the submittal or from meeting requirements of Contract Documents.
3. **After material or equipment has been submitted and approved, no substitutions will be allowed, unless required per Contract Documents. Any equipment installed that is different than the approved shop drawings and submittals will be removed and replaced at the Contractor's expense.**
4. The Contractor may be charged for costs incurred by the Engineer for third and subsequent submittal reviews. Cost for Engineer's review time shall be billed at the Engineer's standard hourly rates.

5. Where calculations, sealed by a registered professional engineer, are required to be submitted, they will be reviewed for content and format but may not be reviewed for accuracy.

F. For control panels, motor starters and other equipment requiring multiple terminations of components and devices, the Contractor shall submit detailed shop drawings on 11" x 17" size sheets consisting of point-to-point wiring diagrams, bill of materials, interior and exterior elevations with dimensions prepared by the equipment manufacturer or a UL 508A recognized system integrator.

1.03 RECORD DRAWINGS AND OPERATION AND MAINTENANCE MANUALS

A. Record Drawings: On completion of work, Contractor shall furnish a complete set of Record Drawings and 11" x 17" size Shop Drawings which properly reflect final locations and sizes of conduit, equipment fixtures, controls, etc., as actually installed. Dimensions shall be included on the Contractor's as-built Drawings showing exact location of underground conduits.

B. Operation and Maintenance (O&M) Manuals: Contractor shall provide O&M manuals for equipment and materials furnished under this contract. O&M manuals must be submitted and approved before final inspection of the project so that they may be used during startup. Soft copies shall be in "pdf" format with "character recognition" and shall include the following as a minimum:

1. A cover sheet to identify the Contractor's name, name of the project, date and description, i.e. "Electrical Equipment O&M Manual".
2. Bookmarks within each section for each major component within.
3. Complete manufacturer name and model number of each item.
4. Descriptive data, component data sheets, wiring diagrams, control panel drawings, etc. from the approved submittals/shop drawings.
5. Complete instructions regarding the installation, operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
6. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
7. Copy of warranties issued on the installation, showing dates of expiration.

C. Hard copies, if required, shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and identified as "Electrical Equipment O&M Manual".

1.04 QUALITY ASSURANCE

A. The Contractor performing the electrical construction and installation shall be a reputable **licensed** Contractor in the State of Utah to do electrical **commercial** construction. Where any electrical work indicated on the Drawings is over 600V, the Contractor must also be licensed do work on High Voltage Electrical and Transmission Lines.

B. The Contractor must be located within a 100-mile radius of the project and have been in that vicinity for a minimum of five (5) years.

C. The Contractor must have a minimum of five (5) years experience as a Contractor installing electrical and instrumentation systems for other projects of similar type, size and requirements. If requested, the Contractor must submit documentation and list of references of recent projects similar to this one.

D. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.

E. Unless otherwise indicated, all equipment and components shall be rated for use in the environment installed. Outdoor equipment shall be weatherproof or rated for outdoor use.

1.05 SPACE REQUIREMENTS

A. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. Final arrangement of equipment and service connections shall allow the unit to be serviced, including space to pull motors, change fuses, and operate switches. Minimum working clearances shall be as required by NEC and local codes.

1.06 COORDINATION

A. Contractor shall coordinate with all other trades to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to interference between work of various trades.

B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineer's consent.

C. Carefully check and coordinate each device location and elevation. Also check routing of all conduits for conflicts with structures, mechanical piping, ducts, etc. to avoid conflicts.

D. No ductwork or heating main or piping conveying fluids shall be installed directly over electrical equipment or electrical equipment rooms. Where this has been violated, the Contractor shall immediately notify the Engineer for assessment.

1.07 REGULATORY REQUIREMENTS

A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), State and local codes, and according to the latest Institute of Electrical and Electronic Engineers (IEEE); American National Standards Institute (ANSI); American Society for Testing and Materials (ASTM); Insulated Cable Engineers Association (ICEA); National Electrical Manufacturers Association (NEMA) Standards; and the latest published regulations of the Federal Occupational Safety and Health Act (OSHA). When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

B. Control panels shall be assembled and wired by a UL 508A recognized panel shop. All control panel components shall be UL recognized or ground fault protected per UL 508A fabrication standards. Each control panel assembly shall be fabricated according to UL 508A Standards and shall bear a serialized UL 508A label.

1.08 WARRANTY

A. In addition to specific warranties required by the Specifications, the Contractor shall leave the entire installation in complete working order and free from defects in materials, workmanship or finish. Contractor shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during the tests and within a period of one year after the work is accepted by the Engineer and Owner. Contractor shall repair or replace existing equipment and work that is damaged during the repair of defective apparatus, materials or workmanship.

B. All manufacturer's warranties shall be filled out in their entirety by the Contractor for the Owner using the Owner's name and address. Unless otherwise specified, equipment warranty periods will commence on date of final acceptance.

1.09 DRAWINGS

A. Clarity and Legibility: For purposes of clarity and legibility, the Drawings are diagrammatic only. Drawings are not intended to show every fitting, junction, gasket or component necessary, nor every difficulty that may be encountered during installation. Conduit routing may be adjusted in the field. Size and location of equipment are drawn to scale wherever possible. Contractor shall refer to related data in all Contract Documents and shall verify this information on site.

B. Instrumentation and control drawings are provided to indicate the control strategy intent only. Final circuitry shall be as determined by the Contractor or his vendors. Actual wiring diagrams shall be provided by the Contractor and reviewed by the Engineer for a fully functional system as intended.

1.10 REFERENCES

A. The specifications reference known standards and codes. Each such standard referred to shall be considered a part of the Specifications to the same extent as if

reproduced therein in full. The following is a representative list of such Associations, Institutes and Societies, together with the acronym by which each is identified.

AASHTO	**American Assoc of State Highway and Transportation Officials**
AIEE	**American Institute of Electrical Engineers**
ANSI	**American National Standards Institute**
ASTM	**American Society for Testing and Materials**
AWWA	**American Water Works Association**
ICEA	**Insulated Cable Engineers Association**
IEEE	**Institute of Electrical and Electronics Engineers**
IES	**Illumination Engineering Society**
NEC	**National Electrical Code**
NEMA	**National Electrical Manufacturers Association**
NETA	**National Electrical Testing Association**
NFPA	**National Fire Protection Association**
UL	**Underwriter's Laboratories, Inc.**

B. Every reference in the Specifications shall mean the latest printed edition of each in effect at the Contract Date.

1.11 UTILITY SERVICE (NOT USED)

1.12 ABBREVIATIONS

A. References on the Drawings to various abbreviations have been made. The following is a representative list of such abbreviations together with the acronym by which each is identified.

AFF	**Above finished floor**
AFG	**Above finished grade**
AI	**Analog input**
AO	**Analog output**
ATS	**Automatic transfer switch**
C	**Conduit**
C/B	**Circuit Breaker**
CKT	**Circuit**
CPT	**Control power transformer**
Cu	**Copper**
DI	**Digital input**
DIST	**Distribution**
DO	**Digital output**
DWG	**Drawing**
GND	**Ground**
GFCI	**Ground Fault Circuit Interrupter**
GFI/GFP	**Ground Fault Indication/Protection**
GRS	**Galvanized Rigid Steel Conduit**
HPS	**High Pressure Sodium**

IMC	**Intermediate Metal Conduit**
INST	**Instrument**
LED	**Light Emitting Diode**
MBJ	**Main bonding jumper**
MCB	**Main Circuit breaker**
MCC	**Motor Control Center**
MCP	**Motor Circuit Protector**
MFR	**Manufacturer**
MLO	**Main Lug Only**
NC	**Normally Closed**
NO	**Normally Open**
NTUA	**Navajo Tribal Utility Authority**
PC	**Personal computer**
PLC	**Programmable logic controller**
PR	**Pair**
REQ'TS	**Requirements**
RTU	**Remote terminal unit**
SES	**Service entrance section**
SPD	**Surge Protective Device**
RMC	**Rigid Metal Conduit (GRS or IMC)**
RVSS	**Reduced Voltage Soft Starter**
SWBD	**Switchboard**
TTB	**Telephone Terminal Board**
TSP	**Twisted Shielded Pair**
TST	**Twisted Shielded Triad**
VFD	**Variable frequency drive**
WP	**Weatherproof**

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Metallic and non-metallic wiring raceways.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's data demonstrating compliance with this specification including couplings, fittings, bushings, and hangers.

B. Submit on the proposed method for separating conduits in underground ductbanks.

1.03 QUALITY ASSURANCE

A. Perform work in accordance with NECA Standard of Installation and NFPA 70.

1.04 RELATED WORK

A. Specification Section 16195, Electrical Identification

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Conduit:

1. Rigid metal, intermediate and EMT:
    a. Allied
    b. Republic
    c. Triangle Conduit and Cable Co.
    d. Wheatland
2. PVC coated rigid steel:
    a. Ocal
    b. Robroy
    c. Calbond
    d. Gafco Green
3. Flexible and flexible water-tight:
    a. Alflex Corp.
    b. Carlon Products Corp.
    c. Carol Cable Co., Inc.
    d. Electri-Flex
    e. Sealtite
4. Non-metallic PVC:

a. Can-Tex
b. Carlon
c. PW Eagle/JM Eagle

5. Conduit supports and hangers:
   a. Caddy
   b. Thomas and Betts
   c. Appleton
   d. Crouse-Hinds
   e. B-Line Systems
6. Supporting Channel:
   a. G-Strut
   b. Unistrut
   c. B-Line

2.02 MATERIALS

A. Metallic Conduit:

1. Rigid steel:
   a. Hot dipped galvanized rigid steel; meet ANSI C80.1 and ASTM A153; UL labeled and meet UL Standard No. 6.
   b. All conduit bodies and fittings shall be threaded. Threadless couplings shall not be used unless specifically approved by the Engineer.
   c. All conduit body covers shall be secured with machine screws threaded onto the conduit body. Covers secured by snaptight or wedge-nuts are unacceptable.
   d. Where PVC coated rigid steel conduit is indicated on the Drawings, the conduit shall be galvanized steel with a factory installed PVC coating. All conduit fitting, boxes, connectors, etc. shall also be PVC coated by the factory.
   e. No aluminum conduit shall be permitted unless approved by the Engineer.
2. Intermediate: Shall be same as rigid above with thinner wall.
3. Electrical metallic tubing (EMT or Thin-wall) shall be:
   a. Galvanized; meet ANSI C80.3; UL labeled; marked with manufacturer's name.
   b. Thin-wall conduit fittings for damp or wet locations shall be of the regular watertight design, with hexagonal nuts and center portions requiring the use of a wrench during installation.
   c. Setscrew type fittings are not permitted under any circumstances.
4. Flexible conduit:

a. UL-listed flexible rubber or plastic coated metallic type with watertight ferrule and sleeve type connectors. Standard steel type flexible conduit is unacceptable.

b. ANSI/NEMA FB1 steel connectors. Connectors must be PVC coated where installed in corrosive environments or where PVC conduit or PVC coated GRS conduit is specified.

B. Non-Metallic PVC Conduit:

1. Rigid non-metallic conduit Polyvinyl Chloride (PVC) type II PVC shall be schedule 40, suitable for use with 90 degree rated wire. Conduit shall bear UL labels for above and below ground use.

2. All PVC conduit 1-1/4 inch and larger with bends greater than 45º shall utilize factory bends.

3. Where the enclosure or raceway is subject to physical damage, conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic conduit or equivalent.

4. Meet UL standard #651.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General:

1. Raceways shall be concealed, where possible, unless otherwise indicated on the Drawings. When exposed, confirm the exact routing with the Engineer prior to roughing in.

2. Sizing: Minimum conduit sizes are indicated on the Drawings. The Contractor may choose to install larger conduit for ease of installation or wiring pulling at no additional cost to the Owner. If conduit or raceway size is not indicated on the Drawings, raceways shall be sized per NEC. Unless otherwise indicated, minimum conduit size shall be ¾ - inches.

3. Unless otherwise indicated, all exposed conduits to be rigid metal conduit GRS or IMC. All direct buried or concrete encased conduits to be Schedule 40 PVC.

B. Conduit:

1. Conduit shall: Have openings temporarily plugged, using “pennies” or equal, to exclude plaster or other foreign materials; be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting, be rigidly supported so as to prevent undue stress or strain on the couplings and connectors; be swabbed before conductors are pulled in.

2. After installation, seal the openings of all conduits in all enclosures using Type DC duct sealing compound/putty as manufactured by O-Z/Gedney or equal.

3. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Horizontal runs shall be run with a slight incline, to prevent low spots or pockets (for drainage).
4. Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to boxes with lock nuts and bushings in such a manner that each system shall be electrically continuous throughout. "Erickson" couplings shall be used where required. No running threads shall be cut.
5. Install conduit systems completely before conductors are pulled. Conduits shall be securely supported at proper intervals to structures with steel clamps, or conduit hangers or by special supporting assemblies when indicated on the Drawings.
6. Conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Provide service entrance and transformer connection conduits with grounding type bushings.
7. Exposed conduits shall be installed parallel to walls, floor and ceilings or at right angles to the building lines. Exposed bends shall be used only where approved. Covers shall be secured to bodies with machine screws.
8. IMC: May be used in lieu of heavy wall rigid, unless otherwise indicated.
9. Electrical metallic tubing (EMT) or "Thin-wall" may not be used except where specifically indicated on the Drawings or as directed by the Engineer.
10. Hickey bends shall not be used for 1-inch and larger conduits. Either manufactured elbows or bends fabricated in a bending machine shall be used. The radius of the inner edge of bends shall be six times the internal diameter of the conduit for conduit sizes up to 2 ½-inches and 12 times internal diameter for 3-inches conduits and larger. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than 360º of total bends.
11. Conduit shall not be run above or below water piping, and must be individually supported.
12. In wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, shall be installed and equipped to prevent water from entering conduit. Conduit shall be so mounted so that there is at least ¼-inch air space between conduit and wall or similar supporting surface.
13. Unless otherwise indicated, PVC coated rigid metal conduit shall be used in the Chlorine Room.
14. Schedule 40 PVC conduit may be used for buried conduit installations as permitted by the NEC and local codes except where galvanized rigid steel

is specified. Couplings, transition fittings, adhesives, primer and installation procedures recommended by the conduit manufacturer and all applicable codes must be strictly followed.

15. Install liquid-tight flexible metal conduit at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to 3-foot maximum.

C. Conduit Supports and Hangers:

1. Conduits shall be individually fastened securely in place on maximum of 8-feet intervals for 1-inch conduit or less and 5-feet intervals for conduits over 1-inch and within 3-feet of each conduit run termination. Use only supports, hangers and fasteners specifically designed for supporting electrical conduits.

2. Where two or more conduits 1-inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized “L” angle iron, or 1-5/8” strut cross members. Such conduits shall be individually fastened to the cross member of every other trapeze hangers with galvanized cast two hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.

3. Hangers shall be made of durable materials suitable for the application involved and shall be painted with two coats of oil paint. Where excessive corrosive conditions are encountered, hanger and strut assemblies shall be protected after fabrication by sherardizing or galvanizing, special paint or other suitable preservative methods.

4. For mounting on concrete or brick construction, insert anchors shall be installed with round head machine screws. In wood construction, round head wood screws shall be used. In brick, inserts shall be near center of brick, not near edge or in joint. Where steel members occur, drill and tap, and use round head machine screws.

D. Sleeves, Inserts, etc.: Lay out and install work in advance of the laying or pouring of floors and erection of walls. Furnish and install sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, furnish and install inserts and clamps for the supporting of conduit. If this Contractor does not properly install sleeves and inserts required, he will be required to do the necessary cutting and patching later, at his own expense, to the satisfaction of the Engineer.

E. Installation of Underground Conduits:

1. Install underground conduit as indicated on the Drawings. Backfill material around the conduits must be clean-fill (dirt with rocks no larger than ½-inch).
2. Conduit bends shall have long sweep radius curves instead of standard elbows where indicated on the Drawings. All PVC conduit bends greater than 45° shall be factory-made for conduits larger than 1-inch.
3. All underground PVC conduit shall be buried a minimum of 24-inches below finished grade, except when located below a concrete slab or freestanding electrical equipment. Conduit shall be installed deeper than 24-inches wherever required to avoid existing piping, tunnels, or other obstructions.
4. Underground conduits in ductbanks shall be separated and supported with pre-manufactured plastic chairs, unless submitted and approved otherwise, installed at 5-foot intervals in the trench.
5. ***After duct is in place, notify the Engineer prior to backfill or concrete pour for inspection.*** Failure to do so will result in removal of all backfill material to expose the conduits for inspection.
6. During backfill, provide plastic warning tape at 12-inches below finished grade over underground electrical installations which reads, "Caution - Buried Electrical Line Below".
7. PVC conduits are permitted to be stubbed up into freestanding electrical enclosures. Where conduit stubs up out of the earth and is exposed, any portion of the conduit with less than 24-inches of cover shall be PVC coated rigid metal conduit or galvanized rigid metal conduit wrapped with 20-mil rubber tape half-lapped to a thickness of 40-mils.
8. Where terminating PVC conduit in a freestanding enclosure, underground junction box, manhole/handhole or other similar locations, provide each termination with a bell end.
9. Rigid metal conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Install grounding type bushings on all service entrance and utility transformer connection conduits.
10. Spare conduits shall be capped with an approved plug.
11. Before pulling cables into underground conduits, pull a mandrel ¼-inch smaller than the conduit inside diameter and pulled through each conduit, and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduits. Underground conduits shall be swabbed before cables are pulled in.
12. After duct runs are completed and set, backfill the trenches and tamp thoroughly to 90 percent compaction. Tamp to 95 percent compaction

where conduits are located under a roadway. Compaction shall be witnessed by the Engineer.

13. Contractor shall label all conduits in underground ductbanks with a black marker before calling for an inspection.

3.02 CONDUIT MARKERS

A. All conduits with conduit designations indicated on the Drawings shall be identified at each termination. See Section 16195 - Electrical Identification for conduit tag requirements.

END OF SECTION

SECTION 16120

WIRES AND CABLES
(600V OR LESS)

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Cables and wires rated 600 volts or less, as specified, including wiring of all devices.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's data on all power, signal and communication cables demonstrating compliance with this Specification.

1.03 QUALITY ASSURANCE

A. Comply with the following Codes and Standards:
   1. NFPA 70 (NEC)
   2. UL listing for materials.
   3. ICEA S-66-524
   4. NEMA WC-7
   5. ASTM B-3 or B-8

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Cable:
   1. General Cable
   2. Okonite
   3. Southwire
   4. Encore

B. Connectors:
   1. Ideal
   2. Burndy Corp.
   3. Thomas and Betts Co.
   4. O.Z. Gedney
   5. Minnesota Mining & Manufacturing (3M)

2.02 MATERIALS

A. Conductors for wire and cable shall be stranded copper with 98 percent conductivity and shall be tinned or untinned in accordance with established standards for the type of insulation around the conductors. Solid conductors are not acceptable.

B. Wire and cable shall be stamped approximately every two feet to indicate voltage, type, temperature rating, and other significant data or warnings.

C. Conductors for general purpose wiring shall meet the following requirements:

1. Power: Type XHHW-2. Minimum conductor size for power shall be No.12 AWG.
2. Control: Type XHHW-2 for conductors run in conduit, minimum size No.14 AWG. Type MTW for conductors contained in control panels, minimum size No.14 AWG or No.16 AWG when protected by an overcurrent device of 10A or less.
3. Analog Signal: Twisted shielded pair (TSP) or triad (TST) with #18 AWG drain wire and an overall PVC jacket rated 600V and rated for wet locations, minimum conductor size No.16 AWG.
4. Ethernet: Category 5e, #24AWG, (4) twisted pairs with shield providing 100% coverage, #24AWG drain wire and an overall PVC jacket rated for wet locations (where applicable) and 600V.

D. Wire Pulling Lubricant: Lubricant shall be UL listed and be of a consistency that will not leave an obstruction or tackiness that prevents pulling out wires in the future. No soap flakes or vegetable soaps will be permitted. Lubricant in shall be Ideal Wire Lube or equal.

E. Cable Ties: Wiring in panels, cabinets, etc. shall be neat and tied with “Ty-Rap” T&B “TY-5418” series, or Panduit Co. “Cable Wrap”. Cable ties used in outdoor locations shall be UV stabilized.

F. Terminations:

1. 3-M Scotchlok lugs and connectors - copper.
2. O-Z solderless connectors, grounding devices, power connectors, armored cable fittings, and cable terminations.
3. Burndy - copper - all types as appropriate for cable size and configuration.

G. Connector material shall be compatible with conductor material to prevent corroding, differences in coefficients of expansion or electrolysis.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Install wires and cables in NEC approved raceways (Section 16110). All wire and cable must be installed in a raceway, unless otherwise indicated on the Drawings.

B. Branch circuit and feeder conductors shall have insulation with the following color. Phase tape is unacceptable.

1. Grounding conductor-Green.
2. Neutral - White.
3. 120/240V Phase A - Black.
4. 120/240V Phase B - Red.
5. 120/208V Phase A - Black.

6. 120/208V Phase B - Red.
7. 120/208V Phase C - Blue.
8. 277/480V Phase A - Brown.
9. 277/480V Phase B - Orange.
10. 277/480V Phase C - Yellow.

C. 6-inch minimum loops shall be provided at each outlet, device or luminaire. Unused wires in outlet boxes, shall be rolled up, connected together and taped or capped with wire nuts. Mark bundled, unused spare wires as "SPARE FROM [origination]".

D. Branch circuit sizing: Where wire size is not indicated on the Drawings, NEC and local codes shall govern. However, minimum branch circuit conductor size shall be No. 12 AWG.

E. Pulling Cables: Wires and cables shall be carefully handled during installation. Lubricant used for pulling in wires and cables shall be used. Use a dynamometer when pulling conductors by mechanical means.

F. Communication and signal cables shall be run in separate raceways from power wiring. Keep separated from power wiring in control panels, wireways and junction boxes. Keep separated from power wiring raceways by a minimum of 12-inches.

G. Bending radius: Do not exceed the manufacturer's maximum bending radius.

3.02 SPLICES AND TERMINATIONS

A. Splices:

1. Splices in conductors shall not be used unless otherwise indicated on the Drawings or approved by the Engineer.
2. Where splices are allowed or necessary, they shall be mechanically strong and well made so that the electrical resistance of a joint shall not exceed that of 2-feet of the conductor.
3. Splices shall be made only in junction boxes and never in conduit.
4. Above Grade Splices:
   a. Utilize wing nut solderless connectors for splicing No. 8 AWG and smaller conductors. Follow manufacturer's recommendations for sizing, stripping, twisting, etc.
   b. Utilize insulated butt connectors crimped end-to-end for splicing No. 6 AWG and larger conductors. Follow manufacturer's recommendations for sizing, stripping and crimping.
5. Below Grade Splices:
   a. Utilize waterproof splice kits or wing nut solderless connectors with cast-resin waterproofing for splicing No. 8 AWG and smaller conductors. Follow manufacturer's recommendations for sizing, stripping, twisting, etc.

b. Utilize insulated butt connectors crimped end-to-end with cast-resin waterproofing for splicing No. 6 AWG and larger conductors. Follow manufacturer's recommendations for sizing, stripping and crimping.

c. Utilize insulated butt connectors crimped end-to-end for all below grade splices or No. 6 AWG and larger conductor splices above grade. Follow manufacturer's recommendations for sizing, stripping and crimping.

B. Motor terminations: Ring type, crimped connectors shall be installed on all conductors and bolted together back-to-back. For terminations with No.6 and smaller wire, use 10-24 bolts. Use bolts that match the connector bolthole size for all other motor terminations. Apply one layer of cambric tape followed by three layers of rubber tape and finally, top with one layer of black vinyl tape.

C. Non-motor terminations: Use ring or fork type, crimped connectors for all screw-on terminations. Wrapping wire around a binding post is unacceptable.

D. Where special tools are required to properly install the particular connector the special tools must be used.

3.03 WIRE MARKERS

A. All conductors shall be labeled at each termination and splice. See Section 16195 - Electrical Identification for wire marker requirements.

END OF SECTION

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Outlet boxes, pull and junction boxes and underground junction boxes.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's data for standard outlet boxes up to six gang, including floor type demonstrating compliance with specification requirements and Drawings.

B. Shop Drawings: Submit drawings for special pull, outlet, and junction boxes demonstrating compliance with NEC and specification requirements. Drawings shall indicate box dimensions and locations in building.

1.03 QUALITY ASSURANCE

A. Comply with the following Codes and Standards:

1. NEMA 250
2. NFPA 70
3. UL listing for materials.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Appleton Electric

B. Crouse-Hinds

C. Killark

D. Raco

E. Hoffman Engineering Co.

F. O.Z. Gedney Co.

G. Steel City

H. Hubbell

I. Rittal

2.02 MATERIALS

A. Outlet boxes for concealed conduits and flush-mounted wiring devices shall meet the following requirements:

1. Stamped, one piece, galvanized steel.
2. Proper size and shape for conduits entering them.
3. UL listed for their application.
4. ANSI/NEMA OS-1 for galvanized steel; ANSI/NEMA OS-2 for non-metallic.

B. Outlet boxes for exposed conduit systems and exterior locations shall be of the threaded-hub, cast-metal, conduit type fitting suitable for the wiring devices to be installed. Covers (blank, switch, receptacle, etc.) shall be the type specifically designed to fit the specified boxes.

C. Above grade electrical junction and pull boxes shall be sheet metal with an ANSI 61 gray color with size and type as indicated on the Drawings. NEMA rating shall be as indicated on the Drawings. Where a NEMA rating is not indicated, outdoor boxes shall be NEMA 3R and indoor boxes shall be NEMA 12. Box sizes shall be as indicated on the Drawings. Where sizes are not indicated or larger size is required to meet code, the box size shall be increased as required by the National Electrical Code.

D. Wireways and troughs:
1. Wireways shall be sized as indicated on the Drawings or as required by the National Electrical Code. Where sizes are not indicated or larger size is required to meet code, the wireway shall be sized such that the cross-sectional area of the wireway at any one point does not exceed 40% per the National Electrical Code.
2. Cover: Hinged with removable latches where feasible.
3. UL listed for steel enclosed wireway or auxiliary gutter.
4. Furnished complete with covers, elbows, tees, junction boxes, end covers, connectors and hangers.
5. Unless otherwise indicated, wireways shall be NEMA 1 for indoor applications and NEMA 3R for outdoor and NEMA 4X for corrosive atmospheres.
6. Wireways in outdoor locations shall be fully gasketed.

E. Underground junction boxes:
1. Construction: Electric underground junction boxes shall be precast concrete and size as indicated on the Drawings. Underground junction boxes shall have precast concrete extensions.
2. Covers: Covers shall be rectangular, reinforced concrete and have the text “ELECTRIC” cast into the cover.
3. Approved Manufacturer: Christy, or equal.

F. Fittings, hangers, fastenings, etc., shall be of material that will prevent chemical reaction between itself and conduit or device it is fastening or supporting.

PART 3 -- EXECUTION

3.01 BOX LOCATIONS

A. Location of Boxes: In order that boxes may be placed in proper locations, the Contractor shall familiarize himself with the details of these spaces and carefully lay out boxes so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause these boxes to be inaccessible for use or maintenance. Contractor shall consult with other Contractors and trades on the project and obtain details of the project to locate outlet boxes properly.

B. Contractor shall be responsible for the exact and proper location of the various portions of his work. Consult the Drawing and details.

C. Mounting Heights: The exact mounting height of each switch, receptacle, light fixture outlet, etc., shall be confirmed on the premises in conference with the Engineer. Unless otherwise indicated, receptacles to be mounted at 18-inches and light switches to be mounted at 42-inches above finished floor/grade.

3.02 INSTALLATION

A. No thru-boxes shall be permitted.

B. Boxes shall meet the following requirements:

1. Proper size and shape for conduits entering them.
2. Installed so that device and/or cover plates shall be tight and plumb with wall finish.
3. Have unused openings closed with knock-out closures.
4. Securely fastened to building or structure.

C. Surface-mounted outlet boxes shall meet the following requirements:

1. Outdoor boxes shall be cast steel or cast aluminum with threaded hubs.
    a. Fastened with not less than two Paine, Phillips, Ackermann-Johnson, or equivalent, screw anchors and round head machine screws on brick and concrete walls or ceilings.
    b. Under no circumstances will drilling of cast boxes be allowed.
    c. PVC coated boxes shall be used for installations with PVC coated rigid steel conduit.
    d. Be provided with a vapor-proof gasket in wet locations or where indicated as “WP” (weatherproof) on the Drawings.
    e. Install a weatherproof-while-in-use cover on all outdoor receptacles.
2. Bell boxes may be used for indoor applications where rigid steel or IMC conduit is required.

D. Flush-mounted outlet boxes shall:

1. Be solid ganged boxes for more than two devices.
2. Contain a plaster ring to bring the wiring device attachment points within ¼-inch of the finished wall surface.

3. Be installed so that device covers are tight and plumb with wall finish.
4. Be installed as close as possible to the lock side of door trim for light switches.

E. Bracket outlets shall be level and centered on columns or above doors when installed in these locations.

F. Pull boxes and junction boxes shall be:
1. Installed in runs of conduit more than 100-feet in length or the equivalent of four 90-degree bends.
2. Entirely accessible.
3. Securely mounted to building structure independent of the conduits connected to them.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Wiring devices such as but not necessarily limited to power receptacles and light switches.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's data for each wiring device including device covers demonstrating compliance with these Specifications and UL labeling.

1.03 QUALITY ASSURANCE

A. Comply with the following Codes and standards:

1. NEMA
2. UL listing
3. NFPA 70

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Hubbell

B. Leviton

C. Bryant

D. Crouse-Hinds

E. Pass & Seymour

2.02 MATERIALS

A. Light switches and receptacles shall meet NEMA WD1 and WD6 standards, be UL listed and be Heavy Duty, **Industrial** Specification grade. Commercial specification grade wiring devices are not acceptable.

B. Amperage rating of each wiring device shall match the circuit's overcurrent device amperage rating to which it is connected.

C. Wiring devices shall have an ivory finish unless otherwise specified.

D. Power receptacles shall be the grounded type. Furnish ground fault circuit interrupter (GFCI) type where indicated on the Drawings or as required by the NEC.

E. All GFCI receptacles shall be listed weather-resistance (WR) type receptacles.

F. Light switches shall be the quiet type.

G. Wiring Device Coverplates:

1. Unless otherwise indicated, coverplates installed indoors or in control panels shall be brushed anodized aluminum.
2. Weatherproof locations: Wiring devices installed outdoors or where identified on Drawings with “WP” shall contain a gasketed coverplate UL approved for wet locations.
3. Where weatherproof-while-in-use coverplates are indicated on the Drawings or required by NEC, power receptacles shall be provided with a cover that is listed for “extra duty” and maintains UL approval for wet locations when a cord is plugged into the receptacle.

PART 3 -- EXECUTION

3.01 INSTALLATION/APPLICATION

A. Devices and coverplates shall be plumb and parallel to adjacent surfaces or trim. Flush-mounted devices must be flush with finished wall surfaces and the coverplates must be tight to surfaces over which they are installed.

B. Receptacles identified as GFCI or when required by the NEC shall have individual GFCI receptacles installed for each outlet. Installing a single GFCI receptacle and standard receptacles connected to the load side of the single GFCI receptacle is unacceptable.

3.02 FIELD QUALITY CONTROL

A. Contractor shall verify that the openings have been properly patched around devices without damage to devices.

B. Damaged or painted devices shall be replaced or cleaned as directed by the Engineer.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. Nameplates and labels

B. Wire and cable markers

C. Conduit markers

D. Section does not include arc-flash labels

1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1. NEC 110-22 Identification of Disconnecting Means
2. NEC 200-6 Means of Identifying Grounded Conductors
3. NEC 200-10 Identification of Terminals
4. NEC 210-5 Identification for Branch Circuits
5. NEC 215-8 Means of Identifying Conductor with the Higher Voltage to Ground
6. NEC 230-70, (B) Service Equipment, Marking
7. NEC 310-11 Marking
8. NEC 310-12 Conductor Identification
9. NEC 400-22 Grounded-Conductor Identification
10. NEC 400-23 Equipment Grounding Conductor Identification
11. NEC 408-13 Panelboard circuit identification

B. UL standard 224- Standard for Extruded Thermoplastic Insulating Tubing.

1.03 SUBMITTALS

A. Product Data: Provide catalog data for the following:

1. Wire and cable marking system
2. Nameplate materials and fasteners
3. Conduit markers

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 -- PRODUCTS

2.01 NAMEPLATES AND LABELS

A. Engraved laminated plastic nameplates with black letters on white background shall be installed on the following as a minimum:

1. Electrical distribution equipment enclosures
2. Disconnect switches and motor controllers
3. Control panels and cabinets
4. Each motor controller or control panel door mounted device
5. Major components, control relays and terminal block strips mounted on the backpanel of control panels

B. Letter Size:

1. Use 3/8-inch letters for identifying electrical distribution equipment enclosures and other large control panels and cabinets. Use 3/16-inch letters for identifying individual control panel components (inside or out) and small control panels/enclosures.

2.02 WIRE MARKERS

A. Manufacturer: Raychem Corporation Model ShrinkMark or equal.

B. Description: heat shrinkable radiation cross-linked, thermally stabilized, modified polyolefin sleeves with 3:1 shrink ratio. Markers shall be UL Standard 224 recognized.

C. Sleeves shall be smear resistant prior to shrinking and achieve mark permanency when shrunk without the need for permatizing equipment. Sleeves should achieve mark permanency when standard ballpoint pens or high-carbon content fabric ribbons are used. The markers shall be flattened and mounted on a carrier suitable for use with commercially available print equipment. Markers shall be printable on both sides. Markers shall be resistant to common industrial fluids including Freon TF, Isopropyl alcohol, and Ethylene Glycol.

D. Locations: Each conductor at each termination and splice.

E. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on the Drawings.
2. Control Circuits: Control wire number indicated on approved schematics, interconnection diagrams and shop drawings.
3. Wire numbers shall be the same at both ends of the wire.

2.03 CONDUIT MARKERS

A. Conduit markers shall be 19 gauge, 1 ½-inch diameter round brass (Brady Part No. 23210 or equal) with engraved, black-filled, 1/4-inch Arial font lettering. Markers shall identify conduit number or designation as indicated on the Drawings. If a conduit is not identified on the Drawings, the Contractor shall consult the Engineer for the proper identification.

PART 3 -- EXECUTION

3.01 NAMEPLATES

A. Install nameplates parallel to equipment lines.

B. Secure nameplates to the exterior of electrical equipment using UL-508A approved die and tapped stainless steel screws (APM SEELSKREW or equal).

C. Secure nameplate to inside surface or backpanels of control panels with a permanent adhesive (Liquid Nails or equal).

3.02 WIRE MARKERS

A. Wire markers shall be a minimum of 3/8-inches in length and placed as near as possible to the end of the wire before heat-shrinking. Orient wire marker such that the writing can be read without turning or twisting the wire.

B. Wire numbers shall be the same at both ends of the wire.

3.03 CONDUIT MARKERS

A. Conduit markers shall be installed near the end of each conduit run and in intermediate locations such as manholes and handholes.

B. Attach brass conduit markers near the end of exposed conduits with 48 mil stainless steel wire (Brady Part No. 38091 or equal) and zinc wire clamps.

C. Secure conduit markers to the floor using a permanent epoxy (Liquid Nails or equal) where conduits terminate in bell ends flush with finished floor in freestanding equipment.

END OF SECTION

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Overcurrent Protective Devices such as fuses and circuit breakers.

1.02 SUBMITTALS

A. Fuses: Submit catalog cuts which indicate the fuse symbol and ampere rating for each disconnect or device.

1. Submit manufacturer's data showing fuse name, symbol, voltage rating, UL class, interrupting capacity or I-squared time (I^2t) characteristics and accessories.
2. Fuse trip curves.

B. Breakers: Submit catalog cuts that indicate type of breaker, size, trip, characteristics, interrupting capacity, and the specified features.

C. Overcurrent Protection Device Coordination Study: Refer to Specifications Section 16010 for requirements.

1.03 OPERATING AND MAINTENANCE MANUALS

1. Identify the size, model and features for each item.
2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
3. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

A. Comply with the following Codes and Standards (see Section 16010):

1. NFPA 70 (NEC)
2. UL listing
3. ANSI
4. NEMA

1.05 RELATED WORK

A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Fuses:

1. Bussmann Mfg. Div.

2. Gould-Shawmut
3. Little-Fuse

B. Circuit Breakers:
1. Square D Co.
2. Cutler-Hammer
3. General Electric Co.

2.02 MATERIALS

A. Fuses:
1. Fuses up to 600 volts shall meet the following:
a. Be of the same manufacturer.
b. Shall NOT be shipped in fused switches.
c. Shall be stored in a safe, moisture free area until needed.
d. All dual element fuses shall have separate overload and short circuit elements. The overload element shall include a spring-assisted thermal unit. The thermal unit shall open on a temperature rise above 280 degrees Fahrenheit. Time delay for the overload element shall be at least 10 seconds at 500 percent of rated amperes.
e. When indicated on the Drawings or required by the local authority or serving utility, fuses shall be silver-sand UL Class R or Class L. current-limiting fuses (low-peak dual element).
f. Motor branch circuit fuses rated 1/10 to 600 amperes shall be sized one ampere rating above the selected heater element. Fuse ampere rating shall not exceed 175 percent of motor FLA. Abnormal motor conditions requiring increased ampere ratings shall be referred to the Engineer. Fuses shall be UL Class R current-limiting dual element with time delay.

B. Circuit Breakers:
1. Low voltage breakers up to 600 volts shall meet the following:
a. Be quick-make, quick-break type.
b. Have toggle mechanism insuring full contact pressure until time of opening whether manually or automatically operated.
c. Thermal magnetic type to have inverse time tripping characteristics with fixed thermal trip action to hold on harmless momentary overload.
d. Adjustable trip setting shall be provided for circuit breakers when necessary to obtain proper trip coordination as determined by the Overcurrent Protection Device Coordination Study.
e. A short circuit condition shall cause the magnetic trip element to instantly trip without damage or injury.

f. Have non-welding, non-corroding contacts.

g. Be full-size with mechanism enclosed in molded bake-lite case, sealed to prevent tampering or unauthorized changes in calibration.

h. Be UL listed and recognized.

i. Meet NEMA standards.

j. Be bolt-on type unless otherwise specified.

k. Have contacts that operate in a multiple plate arc-quenching chamber vented to load side of breaker - UL listed.

l. Be rated for AIC compatible with ratings of the panel or switchboard bus they are to be used in as indicated on the Drawings. Unless otherwise indicated, series rated devices are not acceptable. All overcurrent devices shall be fully rated.

m. Be calibrated for operation in a minimum ambient temperature of 50 degree C.

n. All multi-pole breakers shall have common trip.

o. For multi-pole breakers shall require the same space as the equivalent number of single pole breakers. Wafer style breakers are unacceptable.

p. Have operating handle that visually indicates “on”, “off”, or “tripped”.

q. Be labeled to indicate circuit number(s) and load served.

r. be rated for 100% continuous operation where indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Provide overcurrent protection for all wiring and equipment in accordance with NFPA 70, State or local codes, whichever is prevailing.

B. Should nameplate data disagree with the size or application of an overcurrent protective device indicated on the Drawings, immediately bring it to the attention of the Engineer for a decision.

C. Place a label inside each fused switch door. Label shall indicate fuse type, ampere rating and interrupting rating. Manufacturers’ labels are acceptable.

D. Where blank spaces or spaces designated for future overcurrent devices are indicated on the Drawings, they shall be complete with bus links.

END OF SECTION

SECTION 16480

MINI-POWER CENTERS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Combination transformer/panelboard units commonly referred to by manufacturer trademark as “Mini-Power Center”.

1.02 SUBMITTALS

A. Product Data: Provide catalog data on all components in accordance with this specification including the combination transformer/panelboard and circuit breakers contained within.

B. Provide a panel schedule indicating each circuit breaker with load description.

C. Provide the two-tier series rating of the mini-power center primary circuit breaker with the mini-power center branch circuit overcurrent device where the AIC on the branch circuit overcurrent device has a higher AIC rating than the mini-power center primary circuit breaker.

1.03 OPERATING AND MAINTENANCE MANUALS

1. Identify the size, model and features for each item.
2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
3. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
4. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

A. Comply with the following Codes and Standards:

1. NEMA (Testing Standards BU 1.3.03 or 1.304)
2. UL listing and labeling for materials.
3. NFPA-70

1.05 RELATED WORK

A. Specification Section 16195, Identification

B. Specification Section 16475, Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square D Co.

B. Cutler-Hammer General Electric

C. Or equal

2.02 MATERIALS

A. Mini-Power Centers shall have KVA rating as indicated on the Drawings.

B. Mini-Power Center Units shall include integrally mounted and wired transformer primary and secondary main circuit breakers in accordance with NFPA 70 requirements.

C. Transformer shall have 480V primary and 120/208V, 3∅ secondary as indicated on the Drawings.

D. Transformer shall have 2-5 percent primary taps below normal. Transformer to be encapsulated in a sand-epoxy resin to protect against moisture, rust and corrosive environments.

E. Bussing shall be copper.

F. Branch circuit breakers shall be bolt-on type and as specified elsewhere in these specifications.

G. Enclosures shall be cleaned, phosphatized and electrostatically powder coated and shall be UL Listed for outdoor use. A padlockable hinged access door shall be provided which maintains itself in the open position.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Install where indicated on plans. Mount unit such that it is level and plumb.

B. Prior to installing mini-power centers, coordinate with other trades to verify conduits have adequate space to leave and enter the tub and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.

C. Securely fasten to wall of building or equipment rack with 3/8-inch galvanized steel bolts, nuts and lock-washers.

D. Insert accurate panel schedule on inside of enclosure door or clearly write load description on mini-power center inner door next to each circuit breaker with a permanent black marker.

E. Label each circuit conductor with its associated branch circuit number per Specifications Section 16195.

F. Install nameplate on exterior of Mini-Power Center to indicate panel designation. Fasten nameplate using stainless steel self-tapping screws.

G. Bond secondary of transformer to the service or grounding electrode system with copper grounding conductor sized as indicated on the Drawings or per NFPA 70.

END OF SECTION

SECTION 16481

MOTOR CONTROLLERS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Furnish and install motor controllers as indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

A. Shop Drawings: Submit drawings which include, but not limited to, the following applicable data:

1. Motor designation and horsepower
2. NEMA starter sizes and overload type/sizes
3. Enclosure type with interior and exterior elevations with dimensions
4. Control transformer ratings
5. Circuit breaker (or fuse) sizes
6. Auxiliary contacts
7. Control devices being utilized
8. Point-to-point wiring diagram by an approved system integrator
9. Bill of material including spare parts being furnished

B. Product Data: Submit manufacturer's data showing compliance with the Drawings and these specifications.

1.03 OPERATING AND MAINTENANCE MANUALS

A. Identify the size, model and features for each item.

B. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

D. Copy of warranties issued on the installation, showing dates of expiration.

E. Refer to Specification Section 16010 for additional requirements.

F. The O&M manuals must include a list of adjustable parameters and their as-built values for the solid state soft starter and motor protection relay.

1.04 QUALITY ASSURANCE

A. Comply with the following Codes and Standards (see Section 16010):

1. NFPA 70 (NEC)
2. UL listing
3. NEMA
4. Horsepower application rated
5. IEEE

1.05 JOB CONDITIONS

A. Coordinate with motor manufacturer for whom starters are being furnished to verify starter selected will properly start, run and protect the motor it serves.

1.06 RELATED WORK

A. Specification Section 16120 – Wires and Cables (600V or less)

B. Specification Section 16195 – Electrical Identification

C. Specification Section 16475 – Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Schneider

B. Eaton

C. General Electric Co.

D. Allen-Bradley

2.02 GENERAL

A. Motor controllers shall be of the combination type complete with integral fused disconnect switch, magnetic-only type circuit breaker (MCP) or thermal magnetic circuit breaker as indicated on the Drawings with integral overload protection. Enclosure rating shall be as indicated on the Drawings or as required by the NEC.

B. Where possible, all motor controller components shall be of the same manufacturer.

C. Motor controllers specified herein shall be suitable for use with voltage and phasing as indicated on the Drawings.

D. All motor starters and contactors shall be NEMA rated, minimum size 1.

E. Motor controllers shall be equipped with individual, encapsulated, fused (primary and secondary) control power transformers, unless indicated otherwise on the drawings or herein. Control voltage shall be 120VAC unless indicated otherwise.

F. Overload protection shall be of the electronic type. A pushbutton shall be provided to manually reset the overload protection with the controller enclosure door closed (automatic reset is not acceptable). The overload protection shall be

equipped with a minimum of one normally open and one normally closed auxiliary contact.

G. Motor controllers shall have an externally operated handle to open the disconnecting means. The handle shall have means to be locked in the open position with a minimum of three standard padlocks.

H. Access doors shall be mechanically interlocked with the overcurrent/disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while door is open. Provisions shall be provided for releasing the interlock for intentional access and application of power.

2.03 FULL VOLTAGE NON-REVERSING TYPE

A. Motor controllers shall be NEMA rated.

B. Magnetic controllers shall be equipped with double-break, silver alloy contacts. Controller shall have straight-through wiring.

C. Magnetic controllers through NEMA size 8 shall be equipped with double-break, silver alloy contacts. Controller shall have straight-through wiring.

D. Operating coils shall be of molded construction through NEMA size 8. All coils shall be color coded through size 5 and permanently marked with voltage, frequency and part number.

E. NEMA starters and contactors shall be suitable for the addition of at least three external auxiliary contacts of any arrangement of normally open or normally closed.

F. Motor starters shall be furnished with control features as indicated on the Drawings and as necessary to meet the intent of the Contract Documents. Enclosure ratings shall be as indicated on the Drawings or as required by the NEC.

2.04 NAMEPLATES

A. Each motor controller shall be furnished with a nameplate identifying the load being served as indicated on the Single Line Diagram. Size shall be 1” x 3” minimum. See Section 16195 for additional requirements.

2.05 CONTROL DEVICES

A. Provide control devices and components as necessary to meet the intent of design as indicated on the Drawings and described herein.

B. Operator control devices and pilot lights shall be heavy-duty, oiltight, 30mm. Pilot lights shall be push-to-test, LED style with LED and lens color as indicated on the Drawings. Each operator control device and pilot light shall include an engraved device legend plate, unless the amount of text required exceeds the maximum allowable on a legend plate. If more text is required than allowable, a nameplate per Specification Section 16195 shall be installed. Start pushbuttons shall have

green caps, stop pushbuttons shall have red caps, and emergency stop buttons shall be of the push-pull type and shall have red mushroom type caps. All other button caps and selector switch operator handles shall be black.

C. Control/timing relays shall be of the plug-in style with 120VAC, 10A contacts (DPDT minimum) with On-Off indicator. Standard DPDT control and timing relays shall be interchangeable without changing any wiring. Control relays shall have an LED that is illuminated when the control relay is energized. Timing relays shall have an LED that flashes when the relay is timing. Contacts for switching 4-20mA signal circuits shall contain gold or other noble metal coating.

2.06 TERMINAL BLOCKS

A. Terminal blocks shall be furnished and installed for all field-wiring connections. Terminal blocks shall be rated 30A at 600VAC and mount on a standard 35mm din rail. Each terminal block shall be clearly marked with a terminal block designation per approved wiring diagram. Provide a minimum 25 percent spare terminal blocks.

2.07 ALTERNATING RELAYS

A. Alternating relays: Shall be 120V, solid-state, UL recognized and have heavy-duty contact ratings, Alternating relays shall be plug-in type with a 120VAC, 10A DPDT contacts. A toggle switch on the relay shall be provided to select Motor 1 or Motor 2 without alternating.

B. Acceptable manufacturers

1. Time Mark model 261DT
2. Or equal

2.08 ELAPSED TIME METERS

A. Elapsed time meters shall be non-resettable type, shall read to a maximum of 99999.9 hours, and shall operate when 120VAC is applied. Meters shall contain a bezel for panel mounting with a NEMA 4 rating.

B. Acceptable manufacturers:

1. Cramer Model 635G
2. Yokogawa Model 240 611 AAAD
3. Or equal

2.09 SPARE PARTS

A. Provide the following spare parts in addition to those listed above:

1. Two sets of fuses for each size and type used.
2. Five spare pilot light lamps.
3. One spare control and timing relay of each type utilized.
4. One control power transformer of each size used.

PART 3 -- EXECUTION

3.01 CONTROLLER FABRICATION

A. Motor controllers shall be assembled by the manufacturer or by an approved UL 508A panel fabricator. The entire motor controller or motor control assembly shall be provided with a serialized UL 508A label.

B. Motor control schematics indicated on the Drawings are schematic only. They are provided for bidding purposes to show the intent of control and operation. They are not intended to be actual wiring diagrams. It is the Contractor's responsibility to ensure that all motor controllers are designed and fabricated properly to meet the intent of the Contract Documents.

C. Control wiring shall be type MTW with red insulation (#12 minimum for power, #14 minimum for control). All control wiring shall be contained in plastic wireways with removable covers. Wiring to door mounted devices shall be wrapped in a protective plastic flex. Control wiring installed on enclosure doors shall be secured to door with wire anchors cemented in place. Each control wire shall be clearly identified with a shrink-on wire marker and wire number designation per approved wiring diagrams.

D. All control wiring shall have heat shrinkable wire markers installed near end of wire as specified elsewhere.

E. All field wiring shall be terminated on terminal blocks within the motor controller.

F. Door mounted operator control devices shall be mounted a minimum of 60" above the finished grade level.

G. All enclosure doors with 120VAC mounted devices shall be bonded to the enclosure ground bus.

H. Specialty devices not provided by the motor controller assembler shall be provided to the assembler for their installation into the motor controller. Field mounted devices in the motor controller are unacceptable.

3.02 INSTALLATION

A. Furnish and install all motor controllers as indicated on the Drawings in accordance with the NEC and all applicable industry standards.

B. Prior to installing motor controllers, coordinate with other trades to verify conduits have adequate space to leave and enter the enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.

C. Field-test all motor controllers to demonstrate proper operation. The motor controller fabricator shall be present during startup, testing and commissioning of each motor controller. The Engineer and/or Owner shall witness all motor controller field-testing.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes: Luminaires, ballasts, poles and lamps.

1.02 SUBMITTALS

A. Submit manufacturer's data for the following:

1. Luminaires with designation as indicated on the Drawings, for each one proposed.
2. Luminaire ballasts, for each one proposed.
3. Lamps (type, color, wattage, etc.), for each one proposed.

B. Submit manufacturer's data demonstrating compliance with Specifications and the luminaires as indicated on the Drawings.

1.03 QUALITY ASSURANCE

A. Comply with the following Codes and Standards (see Section 16010):

1. UL listed and labeled.
2. NEMA
3. NFPA 70 (NEC)
4. IES

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Luminaires shall be:

1. Furnished with proper outlet boxes, hangers, hardware, supports, canopy extensions, etc.
2. Furnished complete with lamps with wattage and voltage as indicated on the Drawings.
3. Furnished complete with plaster frames and light tight gaskets when recessed in drywall or plaster ceilings or overhangs.
4. Of the specified finishes and color.

B. Ballasts for fluorescent lighting luminaires shall be the electronic type and shall have the following minimum requirements:

1. UL Listed Class P, Type 1
2. Class A sound rating with no audible noise
3. Operate at an input voltage of 108 to 132 (120 Volt Circuit) at an input frequency of 60 HZ. Light output shall remain constant for line voltage fluctuation of plus or minus 5 percent.

4. Ballast shall be of the programmed start type.
5. No polychlorinated Biphenyl's (PCB'S) contained in the Ballast.
6. No potting compound, maximum ballast weight shall be 1.25 pounds.
7. Total harmonic distortion shall be less than 10 percent.
8. Third harmonic distortion shall be less than 8 percent.
9. Power factor shall be greater than 0.95.
10. Lamp flicker shall be less than 2 percent.
11. Lamp current frequency shall be greater than 25 KHZ.
12. Ballast shall be rated for T-8 lamps.

C. Lamps:

1. LED's and their driver shall be designed for minimum operational life of 50,000 hours in -20°C - 40°C ambient air temperature. The lumen output shall not decrease by more than 20% over the operational life. The driver shall decrease output power when the ambient air temperature is outside the -20°C - 40°C range instead of shutting the LED's off. The driver shall be UL listed and include a quick disconnect plug for maintenance. Kelvin temperature shall be 4000K unless otherwise indicated on the Drawings.
2. Fluorescent lamps shall be T-8 and rated for programmed start ballasts. Lamp types shall be as follows:
   a. Cool white, 3150 lumens
   b. Color Rendering Index (CRI): Lamps shall have a minimum CRI of 70 through the use of RE-70 or RE-80 rare earth phosphor coatings.
3. Metal-halide lamps shall be "pulse-start" for 400 watts and below.

D. Exterior Lighting:

1. Exterior luminaires shall be furnished complete with gaskets, cast aluminum weatherproof outlet box, UL Listed for wet locations, have lamp bases coated with an inhibitor to prevent base from corroding to the socket and be solidly grounded.

PART 3 -- EXECUTION

3.01 INTERFERENCES

A. Contractor shall carefully examine the complete areas as well as each individual room where luminaires are to be installed, for interference with piping and other trades. Where such interferences occur, provide luminaires with proper type suspension to overcome such interferences.

3.02 INSTALLATION

A. Luminaires shall be installed parallel with walls and ground for a neat appearance. Where luminaires are indicated to be mounted on a perimeter wall,

luminaires shall be installed on a flush mounted box at an elevation such that the top of fixture is flush with the top of wall.

B. Operate luminaires after installation and connection. Check for proper operation. Relamp luminaires that have failed lamps.

3.03 OPERATION

A. Lighting shall be controlled as indicated on the Drawings.

END OF SECTION

DIVISION 17

INSTRUMENTATION

SECTION 17500

GENERAL INSTRUMENTATION

PART 1 -- GENERAL

1.01 SYSTEM DESCRIPTION

A. This section includes the general requirements for furnishing and installing the Instrumentation, Control and Monitoring equipment as indicated on the Drawings and specified in Division 17 of these specifications. Other instrumentation and control sections of this Division shall supplement this Section as necessary.

B. The intent of the instrumentation and control sections of Division 17 is to require that all instrumentation as indicated, specified and/or required, shall be furnished by a single competent, qualified Instrumentation and Control Subcontractor (hereinafter referred to as the I&C Contractor) to assure system compatibility and coordination with all other subsystems.

C. The Contractor with his I&C Contractor shall provide all labor, materials, and incidentals as indicated, specified and required to furnish, install, calibrate, adjust, test, document, start-up and train for a complete, integrated and functionally operational Instrumentation and Control System as is intended by these Contract Documents. The system includes but is not necessarily limited to the following major equipment:

1. RTU and Radio Telemetry System programming
2. Filter Control Panel PLC programming
3. Field Instruments

D. The Contractor shall be responsible for coordination of the installation, programming, SCADA computer graphics modifications, onsite startup and testing of the RTU/telemetry and Filter Control Panel with the Engineer and NTUA. The Contractor shall also be responsible of coordination of the installation, onsite startup and testing of the RTU with the Engineer and NTUA.

E. Labor, materials, apparatus, and components essential to the complete functioning of systems described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, the Contractor shall refer to the Engineer for supplemental instructions.

F. All items not specifically mentioned in these specifications or noted on the Drawings, or on shop drawings, but which are necessary to make a complete and satisfactory, working electrical/instrumentation installation, shall be deemed to be included herein. The Construction Documents are not intended to show every fitting, junction, or component nor every difficulty that may be encountered during installation or coordination with different equipment manufacturers. The Contractor shall refer to related data in all Contract Documents and shall verify this information on site.

G. Unless otherwise indicated, all equipment and components shall be rated for use in the environment installed. Outdoor equipment shall be weatherproof or rated for outdoor use. Equipment installed in corrosive areas shall be rated for that environment. In case of doubt as to the area classification, or need for explanation thereof, or discrepancies noted between components specified and the environment installed the Contractor shall consult with the Engineer for supplemental instructions.

H. RTU's and PLC's shall be programmed by the Owner. The Contractor shall coordinate the installation, wiring and programming of the RTU's and PLC's with the Engineer and Owner, as well as make provisions for on site startup and testing of the equipment.

1.02 SUBMITTALS

A. Submit number of copies as specified elsewhere in these specifications. If not specified elsewhere, submit minimum of six (6) copies. Refer to individual Specification Sections for products requiring submission.

B. Submit Division 17 in one submittal, or at a maximum, the following may be submitted as separate submittals for this project.

1. Section 17510 – Field Instruments
2. Sections 17520, 17530/17531

C. Documentation must be arranged in numerical sequence corresponding with each Specification Section and article of each Section. Soft copies shall be in "pdf" format with "character recognition" and shall include the following as a minimum:

1. A cover sheet to identify the Contractor's name, name of the project, date and description, i.e. "Division 17 – Field Instruments".
2. An index corresponding to each specification section with all addendum updates included. Each paragraph or bulleted item shall be check marked to signify compliance with each item and the information is included in the submittal package. If full compliance is not met for any reason, the non-compliance item shall be underlined and reference to a detailed written explanation of the deviation or non-compliance shall be provided in the margin to the right of the specification paragraph or bulleted item for consideration.
3. Bookmarks within each section for each major component within.
4. Complete manufacturer name and model number of each item. Listing items "as specified" without both make and model or type designation is not acceptable.
5. Descriptive Data: Submit copies of complete descriptive literature, performance data, physical dimensions, power and signal connections for each component and equipment to be furnished. Provide name of manufacturer, style, and complete model number. Listing items "as

specified" without both make and model or type designation is not acceptable.

6. Component Data Sheets: Submit a component data sheet for each piece of instrumentation equipment similar to an ISA S20 form. Include equipment tag number, manufacturer's model number, location of service, materials of construction, size and scale range, calibrated range, setpoints, optional accessories and any other useful information.

D. Hard copies, if required, shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and identified as "Instrumentation O&M Manual".

E. Important Notice:

1. After material or equipment has been submitted and approved, no substitutions will be allowed. Any equipment installed that is different than the approved shop drawings and submittals will be removed and replaced at the Contractor's expense without exception!

2. If Contractor's submittal(s) depart from the Contract Documents, the Contractor shall make specific mention thereof in his letter(s) of transmittal, otherwise review of such submittals by the Engineer shall not constitute review of such departure(s).

3. The Contractor may be charged for costs incurred by the Engineer for third and subsequent submittal reviews. Cost for Engineer's review time shall be billed at the Engineer's standard hourly rates.

4. Where calculations, sealed by a registered professional engineer, are required to be submitted, they will be reviewed for content and format but will not be reviewed for accuracy.

F. Control Panel Drawings: Submit 11" X 17" detailed shop drawings with interior and exterior elevations with dimensions, component layout, mounting details, point-to-point wiring diagrams, nameplate legends and bill of materials prepared by a UL 508A recognized system integrator.

1. Wiring diagrams shall include all interconnections, inter-wiring and terminals between all electrical and/or instrumentation units. Wire numbers shall be continuous from start to finish. Wire numbers shall not change when going from one unit, cabinet, enclosure, terminal or any device to another.

2. Discrete control and power circuits: Submit ladder diagrams indicating all panel devices related to discrete functions mounted in or on control panel. Show unique rung numbers on left side of each rung. Label each wire, coil and terminal block. Show individual component terminal numbers.

3. Analog signals: Indicate the entire analog loop on the wiring diagram including all devices connected in series and location of each device.

Indicate loop power supplies and individual component terminal numbers. Indicate wire and terminal numbers of each device in the loop.

4. Use different symbols for terminal blocks located in different pieces of equipment. Label each terminal block and wire termination point.
5. If applicable, show each PLC I/O point rack, slot, terminal number and PLC configured address on each drawing.
6. Submit a block diagram of the distributed control and monitoring system network.

1.03 OPERATING AND MAINTENANCE MANUALS

A. Operating and Maintenance Manuals (O&M): The Contractor shall provide O&M manuals for equipment and materials furnished under this contract. Submit number of copies as specified in Division 1 of these specifications (min 4). Information shall be assembled in individual indexed volumes identifying the size, model, and features indicated for each item. Each copy shall include the following information as a minimum:

1. 3-ring binders (2-inch max) and include tabs and neatly typewritten index. The binder cover and edge shall be identified as "Instrumentation O&M Manual" and shall include the date and name of the project.
2. Identify the size, model, and features for each piece of equipment.
3. Complete instructions regarding the installation, operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
4. Bill of Materials, component data sheets, descriptive literature, product specification sheets, wiring diagrams and calibration procedures. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
5. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
6. Copy of warranties issued on the installation, showing dates of expiration.
7. Provide a copy of all instrument calibration reports.
8. Soft copy shall be on a CD, "pdf" format – including "character recognition", and shall include all information provided in hard copy. CD's must be properly labeled with the following as a minimum: Facility Name, Project Title and Title of Manual.

1.04 OPERATION AND MAINTENANCE DATA

A. As-built wiring diagrams showing connections to all devices; input and output, analog and discrete. Include a complete Bill of Materials indicating each system component by model number.

1.05 RECORD DRAWINGS

A. Record Drawings: Upon completion of work, Contractor shall furnish a complete set of Record Drawings and Shop Drawings which properly reflect final tested system, loop diagrams, PLC programs, etc., as actually installed. Drawings shall accurately record the final constructed system and shall be labeled as "RECORD".

1.06 REFERENCES

A. The specifications reference known standards and codes. Each such standard referenced shall be considered a part of the Specifications to the same extent as if reproduced therein in full. The following is a representative list of such Associations, Institutes and Societies, together with the acronym by which each is identified.

AIEE	**American Institute of Electrical Engineers**
ANSI	**American National Standards Institute**
ASTM	**American Society for Testing and Materials**
ICEA	**Insulated Cable Engineers Association**
IEEE	**Institute of Electrical and Electronics Engineers**
NEC	**National Electrical Code (2005)**
NEMA	**National Electrical Manufacturers Association**
NETA	**National Electrical Testing Association**
NFPA	**National Fire Protection Association**
UL	**Underwriter's Laboratories, Inc.**

B. Every reference in the Specifications shall mean the latest printed edition of each in effect at the Contract date or latest edition as adopted by the local governing authority.

1.07 SYSTEM RESPONSIBILITY

A. The I&C Contractor shall have total responsibility for the work as specified in the instrumentation and control specifications of this Division of these Specifications. This includes but is not necessarily limited to furnishing system components, system integration and design, wiring diagrams, loop drawings, installation supervision, field instrument calibration, start-up, testing and operator training.

B. The I&C Contractor is a Subcontractor. Therefore, references made to the responsibilities and requirements of the I&C Contractor shall only mean that the responsibilities and requirements pass through the I&C Contractor but the final responsibility rests with the Contractor.

1.08 QUALITY ASSURANCE

A. The I&C Contractor shall be a reputable system integrator and be an Underwriters Laboratory (UL) 508A recognized panel fabricator. The I&C Contractor must be

located within a 500 mile radius of the project and have been in that vicinity for a minimum of five (5) years.

B. The I&C Contractor must have a minimum of five (5) years experience as a system integrator, panel fabricator and instrumentation supplier for other projects of similar type, size and requirements. The Contractor must submit documentation from his selected I&C Contractor verifying the experience and UL 508A file number.

C. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.

1.09 COORDINATION

A. The I&C Contractor shall coordinate with all other equipment manufacturers to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to conflicts between various equipment.

B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineer's consent.

C. The Contractor shall be responsible for coordination of control panel fabrication, testing and instrumentation system installation with configuration of the PLC, radio modem and operator interface. Project completion will not be granted to the Contractor until programming and configuration has been completed and complete automatic operation has been tested.

1.10 WARRANTY

A. In addition to specific warranties required by the Specifications, the Contractor shall leave the entire installation in complete working order and free from defects in materials, workmanship or finish. Contractor shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during the tests and within a period of one year (minimum, or as indicated elsewhere) after final acceptance. The Contractor shall repair or replace existing equipment and work that is damaged during the repair of defective apparatus, materials or workmanship at no cost to the Owner.

B. All manufacturer's warranties shall be filled out in their entirety by the I&C Contractor for the Owner using the Owner's name and address. Equipment warranty periods will commence on date of final acceptance.

PART 2 -- PRODUCTS

2.01 STANDARD EQUIPMENT

A. Unless a specific product by manufacturer and model number has been called out, furnish and install equipment of the type specified which has been proven to operate successfully. Material or equipment that has been specified or called out

by manufacturer and/or model number must be supplied with **no substitute.** All other equipment may be selected based on equal quality and performance.

B. All control panel components shall be UL recognized or ground fault protected per UL 508A fabrication standards. Each control panel assembly shall bear a serialized UL 508A label.

C. All instrumentation equipment and control panel components shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 50°C, and specifically rated for the altitude in which the equipment will be placed in service.

2.02 SPARE PARTS AND ACCESSORIES

A. Furnish any special tool required for maintenance or routine calibration of equipment.

B. Refer to individual Sections within this Division for required spare parts.

PART 3 -- EXECUTION

3.01 FACTORY ACCEPTANCE TEST (FAT)

A. Before delivering any control panels to the site, the I&C Contractor shall notify the Engineer in writing at least two weeks prior so that a factory acceptance test can be performed. The test shall be conducted only after the I&C Contractor and Owner have performed their programming, operator interface configuration, testing and functional checkout of the system including PLC logic. The PLC and operator interface programs shall be thoroughly tested. Each input and output signal shall be tested for proper indication and control function.

B. The factory acceptance test shall be conducted by the I&C Contractor with the Programmer present. The test shall be witnessed by the Engineer.

C. A successful factory acceptance test only allows the I&C Contractor to ship the system to the site. It does not constitute final acceptance by the Owner.

3.02 INSTALLATION SUPERVISION

A. The I&C Contractor shall furnish the services of instrumentation technicians or control system engineers trained and experienced in the installation of the various instrument and control equipment being supplied. These services shall be utilized by the Contractor as he deems necessary to supervise installation, calibrate, troubleshoot and put equipment into service.

3.03 INSTRUMENT CALIBRATION

A. The I&C Contractor shall provide the services of a factory representative with the proper tools and equipment to properly calibrate and adjust each instrument in the field. The Engineer shall be notified when the factory representative will be onsite to witness instrumentation calibration and setup. This site visit by the factory representative may also be utilized for the Owner designated operator training as required below.

B. Each instrument shall be tested with certified test instruments simulating inputs at 0, 25, 50, 75 and 100 percent of the calibrated range. Ten (10) data points shall be recorded by ascending to 100 percent than descending back to 0. Data shall be recorded on a prepared Instrument Calibration Report with the following information:

1. Instrument description
2. Type and location of service
3. Manufacturer, model and serial number of instrument
4. Scale range and engineering units
5. Testing method and description
6. Input values or settings
7. Output values (recorded data)
8. Calibrations notes or explanations
9. Technician's name, date and signature
10. Copy of the test instrument calibration report. Testing instrument must have been calibrated within one year prior to calibration date.

3.04 START-UP AND COMMISSIONING

A. Upon completion of installation, the Contractor shall test the control system for proper operation after making final connections. After the Contractor has successfully started up and tested all system components, the start-up and testing shall be performed again with the City and the Engineer present.

B. The Contractor shall notify the Engineer and City in writing when he considers the system is complete and in good working order for scheduling the start-up and testing date. If retesting is required, the Contractor shall follow this same procedure.

3.05 FINAL ACCEPTANCE

A. Upon completion of instrument calibration and system validation, all systems to be retested under process conditions. The Owner, Engineer and Contractor shall perform this test as a final acceptance test for each instrument or piece of equipment. The process variables will be pushed to their limit to verify accuracy, alarms and interlocks. Any defects or problems will be corrected immediately. Once all testing has been completed to the Owner's satisfaction, the I&C Contractor shall submit a certified report with all substantiating data sheets indicating that the total instrumentation and control system meets the functional intent of the Contract Documents.

B. After installation of the system and checkout by the Owner, Engineer and Contractor, a 30-day acceptance test shall be performed. The 30-day acceptance test shall include an operational demonstration of at least 30 days during which the system shall run continuously without loss of basic functions. The operational demonstration shall confirm that the status, alarm, and process variable signals are valid and are being updated appropriately. During the operational demonstration,

the Owner shall record all errors or abnormal occurrences. The Contractor shall investigate the problems and log his observations including a description of the problem, its apparent cause, and the action taken, if any, to recover from the occurrence. Repeated failure of any hardware component shall cause the acceptance test to be terminated and restarted.

3.06 OPERATOR TRAINING

A. The I&C Contractor shall provide factory trained personnel for each field instrument to perform Owner designated operator training of each system. The training shall be done in a group session for a minimum of 1 day or may be incorporated during calibration and setup as described above. The training shall cover the basic system operation, calibrations, adjustments, routine maintenance and repair.

END OF SECTION

SECTION 17510

FIELD INSTRUMENTS

PART 1 -- GENERAL

1.01 SYSTEM DESCRIPTION

A. This section includes the general requirements for furnishing and installing the field instruments as indicated on the Drawings and specified in this Division of these specifications. Other instrumentation and control sections of this Division shall supplement this Section as necessary.

B. The Contractor with the I&C Contractor shall provide all labor, materials, and incidentals as indicated, specified and required to furnish, install, calibrate, adjust, test, document, start-up and train for each field instrument furnished.

C. Labor, materials, apparatus, and components essential to the complete functioning of field instruments described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, the Contractor shall refer to the Engineer for supplemental instructions.

D. For purposes of clarity and legibility, the Drawings are diagrammatic only. Construction Documents are not intended to show every fitting, junction, or component nor every difficulty that may be encountered during installation or coordination with different equipment manufacturers. The Contractor shall refer to related data in all Contract Documents and shall verify this information on site.

1.02 SUBMITTALS

A. Descriptive Data: Submit copies of complete descriptive literature, performance data, physical dimensions, power and signal connections for each field instrument to be furnished. Provide name of manufacturer, style, and complete model number. Listing items “as specified” without both make and model or type designation is not acceptable.

B. Component Data Sheets: Submit a component data sheet for each piece of instrumentation equipment similar to an ISA S20 form. Include equipment tag number, manufacturer’s model number, location of service, materials of construction, size and scale range, calibrated range, setpoints, optional accessories and any other useful information.

C. Submit drawings and bill of materials for any sun shields that may be required. Drawings must clearly indicate how the sun shield will be fabricated and mounted.

D. Submit instrument tags including a list of designations and instrument numbers to be indicated on each tag.

1.03 OPERATING AND MAINTENANCE MANUALS

A. Installation requirements and procedures.

B. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

C. Bill of Materials, descriptive literature, wiring diagrams and calibration procedures. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

D. Component data sheets, product specification sheets and calibration procedures from the approved submittals shall be included.

E. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

F. Provide a copy of all instrument calibration reports.

G. Refer to Specification Section 17500 for additional requirements.

1.04 COORDINATION

A. The Contractor shall coordinate with all other equipment manufacturers and trades to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to conflicts between various equipment.

B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineers consent.

1.05 IDENTIFICATION TAGS

A. All field instruments shall have an identification tag meeting the following requirements:

1. 19 gauge, 2-inch square stainless steel (Brady Part No. 44403 or equal)
2. Device designation **and** field instrument number shall be permanently etched or embossed onto the stainless steel tag with engraved, black-filled, 1/4-inch Arial font lettering.
3. Device designation and instrument number on tag shall be as indicated on the Drawings.
4. Tags shall be fastened to the instrument housing with stainless steel rivets, self tapping screws or with 48 mil stainless steel wire (Brady Part No. 38091 or equal) and zinc wire clamps.
5. Identification tags must be installed on **all** field instruments whether provided by a vendor as part of a packaged system or not.

PART 2 -- PRODUCTS

2.01 MAGNETIC FLOWMETERS

A. General

1. Magnetic flowmeters systems shall be of the low frequency electromagnetic induction type and produce a DC pulsed signal directly proportional to and linear with the liquid flow rate. Complete zero stability shall be an inherent characteristic of the flowmeter system. Each magnetic flowmeter system shall include a metering tube, signal cable, transmitter and flowmeter grounding rings.
2. Magnetic flowmeters and electronics shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

B. Metering Tube:

1. Constructed of 304 or 316 stainless steel with 150 lb. carbon or stainless steel AWWA Class D flanged connection.
2. Utilize a minimum of 2 bullet-nosed, self-cleaning electrodes.
3. The liner shall be non-conductive and in conformance with the Manufacturer's recommended service.
4. Electrodes shall be constructed of 316SS, unless other material is recommended by the flowmeter manufacturer for the liquid being measured.
5. Meter housing rated for accidental submergence (for FM's in underground vaults only).
6. Two stainless steel grounding rings shall be furnished and installed in accordance with the manufacturer's bore and material recommendation for the meter's intended service. Installation shall be per flowmeter manufacturer's recommendations. Unless otherwise indicated, flowmeter grounding shall consist of a ¾" x 10-foot copperclad ground rod bonded to the grounding rings with a No.6 bare copper conductor.

C. Transmitter:

1. Transmitters shall be mounted on the flowtube or mounted remote from the flowtube as indicated on the Drawings. The interconnecting cable shall be furnished by the flowmeter manufacturer of sufficient length to avoid splicing. Transmitters shall be housed in NEMA 4 enclosures suitable for mounting outdoors. The transmitter shall produce an electrically isolated 4-20mA DC output into a minimum load of 800 ohms linear to flow and a dry-contact, field adjustable, pulsed output for remote totalization.
2. Transmitter shall be furnished with a dry contact that closes for remote monitoring of a reverse flow condition.
3. Integral mounted transmitters shall be furnished with sun shades which mount directly onto the transmitter.

D. Performance Requirements:

1. Time Constant: 0.5 to 1000 seconds.
2. Accuracy: 0.50 percent of flow rate from 10 to 100 percent of full range over 1 ft. per second.
3. Repeatability: 0.25 percent of full scale.
4. Isolation: either galvanic or optic
5. Empty pipe detection: The flow transmitter shall display "Empty Pipe" when the metering tube is not completely full.
6. Power consumption: 30 watts max
7. Power supply: 24VDC.

E. Factory Testing

1. Each flowmeter shall be hydraulically calibrated at a facility that is traceable to the National Institute of Testing Standards using a 3-point (minimum) test. The calibrations procedures shall conform to the requirements of MIL-STD-45662A. A real-time computer generated printout of the actual calibration data indicating apparent and actual flows for each flow test shall be submitted to the Engineer within thirty (30) days prior to shipment of the meters to the project site.

F. Acceptable Manufactures:

1. Endress + Hauser Promag 50W
2. Or Equal

2.02 ULTRASONIC LEVEL SENSORS

A. The ultrasonic level meter shall consist of a transducer with an integral internal temperature sensor, an indicating/transmitter logic unit and interconnecting cable. The transducer shall be capable of sensing level changes in solids or liquids through the use of transmitted ultrasonic pulses that reflect back to the transducer. The transmit/return times are converted into digital indications of level, flow, and/or totalized volume by the logic unit. The transducer shall be suitably constructed for use in corrosive and/or hazardous locations such as raw sewage wetwells. The logic unit shall be capable of monitoring the level in vessels (such as sewage wetwells, enclosed tanks) and calculating volume measurement and totalized volume. The meter shall provide accurate readings even when used where objects such as agitators may tend to produce inaccurate readings, where turbulence of targeted surface is present, and where steam is present above targeted surface. The meter and transducer shall have the following functions and features as a minimum:

1. Approvals: CSA Class 1, Gr. A,B,C,D; FM Class 1, Div. 1
2. Operating power: 120VAC, 60 Hz, unless otherwise indicated
3. Transducer separation: up to 600 ft. from logic unit
4. Level range: as indicated elsewhere
5. Blanking: adjustable from 0.3 M (1 ft).

6. Display: Four character LCD with five LED status points
7. Discrete outputs: 4 SPDT relay outputs (5A, 220VAC contacts), independently adjustable over entire range.
8. Analog output: isolated 4-20 mA linearly proportional to level
9. Pulsed output: Where indicated on the Drawings, a dry-contact, pulsed output shall be provided that can be field adjustable to pulse each time a predetermined flow quantity has passed through the flowmeter.
10. Operating temperature range: -20 to 50 deg C.
11. Resolution: greater of +/-0.1% of range, or 2 mm.
12. Accuracy: +/- 0.25% of range
13. Memory protection: EEPROM
14. Enclosure rating (logic unit): polycarbonate, NEMA type 4

B. The Contractor shall furnish and install all mounting hardware and support structures for the transducer (and temperature sensor) and the logic unit as required for proper operation in accordance with the manufacturer's recommendations and the Contract Documents. Materials used for support structures shall be suitable for the environment in which it is installed (corrosive - stainless steel, non corrosive - galvanized steel; unless indicated otherwise).

C. The transmitter shall be furnished with a hand held programmer for parameter configuration.

D. The transducer shall be supplied with cable of sufficient length to reach the transmitter without a splice.

E. Acceptable Manufacturers:

1. Hawk Miniwave model MWN1A
2. Or equal

2.03 CONDUCTIVITY PROBES

A. Unless otherwise indicated or required for the application, electrodes shall be ANSI Type 316 stainless steel suspended type (except probes contained within a probe bottle and less than six feet in length may be the solid rod type) with a PVC outer sheath and electrode holders shall contain an ANSI Class 125 flange or external pipe flange. Electrodes shall be furnished with cable of sufficient length to facilitate proper operation.

B. A mating flange, pipe, etc. shall be installed as necessary to properly mount the probe holder and provide easy access for maintenance. Probe holder shall be weatherproof, rated for outdoor use.

C. Electrode relays shall be solid-state, octal plug-in type with two SPDT output contacts rated not less than 5 amps at 120 VAC. The relay shall contain an LED status indication, increasing/decreasing time delay functions (5-seconds, unless otherwise indicated) and integral surge protection. The relay coil power shall be 120 VAC, 60 Hz, single phase. Intrinsically safe solid-state relays shall be

utilized whenever the electrodes are located in a hazardous or explosion-proof classified area.

D. Electrodes and conductance relays shall be:
   1. Warrick Controls
   2. B/W Controls
   3. Or equal

2.04 PRESSURE GAUGES

A. Pressure gages shall have the following features as a minimum:
   1. Housing: 4-1/2", aluminum case with glass lens, white dial and black numbers/graduations/pointer
   2. Silicone oil filled
   3. Range: 0 – 100 psi
   4. Proof pressure: 150 percent of range psi minimum
   5. Accuracy: one percent of full scale
   6. Wetted material: 316 stainless steel
   7. Dial/pointer: stainless steel or aluminum
   8. Service: liquid, gas, or vapors as indicated on the Drawings
   9. Process connection: 1/4" NPT male
   10. Calibration: micro-adjustment screw
   11. Accessories: test cock, female outlets and an isolation ball valve

B. An isolation ball valve shall be furnished and installed on each pressure gauge for ease of removal without disruption of service. The valve shall be sized as required for the process connection.

C. A diaphragm seal with flushing connection shall be furnished and installed to isolate each pressure gauge installed with a process connection other than potable water or clean air.

D. The Contractor shall furnish and install all mounting hardware and support structures necessary for proper operation in accordance with the manufacturer's recommendations and the Contract Documents. Materials used for support structures shall be suitable for the environment in which it is installed (corrosive - stainless steel, non corrosive - galvanized steel; unless indicated otherwise).

E. Acceptable Manufacturers:
   1. US Gauge (Ametek)
   2. Ashcroft
   3. Winters
   4. Or equal

2.05 PRESSURE SWITCHES

A. Pressure switches shall be of the snap-action, switch actuated, Bourdon tube type with a visible calibrated dial and pointer(s) indicating switch setting(s). Function shall be for gauge pressure, external field adjustable with a trip point repeatability of 1% of actual pressure. Pressure switches shall have the following features and functions as a minimum:

1. Housing: NEMA 4 except where mounted in a separate enclosure
2. Range: As indicated on the Drawings or as required for the application
3. Proof pressure: 150 percent of range psi minimum
4. Actuating element: Single point service - 316 SS Bourdon tube
   Dual point service - 304 SS Bourdon tube
5. Electrical switch: Mercury switch, SPDT, 120VAC, 10A min except for potable water applications, which shall utilize snap-action type switch, SPDT, 120VAC, 10A min
6. Service: liquid, gas, or vapors
7. Process connection: 1/4" N.P.T. male

B. An isolation ball valve, union and "T" fitting with plug shall be furnished and installed on each pressure switch for ease of removal and calibration without disruption of service. The valve and fittings shall be sized as required for the process connection.

C. A diaphragm seal with flushing connection shall be furnished and installed to isolate each pressure switch installed with a process connection other than potable water or clean air.

D. The Contractor shall furnish and install all mounting hardware and support structures necessary for proper operation in accordance with the manufacturer's recommendations and the Contract Documents. Materials used for support structures shall be suitable for the environment in which it is installed (corrosive - stainless steel, non corrosive - galvanized steel; unless indicated otherwise).

E. Where indicated on Drawings or as required for dual control, pressure switches shall have an adjustable deadband for setting separate open and close operating pressures. Minimum adjustable deadband setting shall be no greater than 20 psi.

F. Acceptable Manufacturers:

1. Mercoid, DA/DS series
2. Or equal

2.06 DIFFERENTIAL PRESSURE SWITCHES

A. Differential pressure switches shall be of a dual- diaphragm sealed piston actuator. Function shall be for differential pressure, external field adjustable with a trip point repeatability of 1% of actual pressure. Pressure switches shall have the following features and functions as a minimum:

1. Housing: NEMA 4 except where mounted in a separate enclosure
2. Range: As indicated on the Drawings or as required for the application

3. Proof pressure: 150 percent of range psi minimum
4. Actuating element: Dual-diaphragm sealed piston
5. Electrical switch: snap switch, SPDT, 120VAC, 10A
6. Service: liquid, gas, or vapors
7. Process connection: 1/4" N.P.T. female

B. An isolation ball valve, union and "T" fitting with plug shall be furnished and installed on each differential pressure switch for ease of removal and calibration without disruption of service. The valve and fittings shall be sized as required for the process connection.

C. A diaphragm seal with flushing connection shall be furnished and installed to isolate each pressure switch installed with a process connection other than potable water or clean air.

D. The Contractor shall furnish and install all mounting hardware and support structures necessary for proper operation in accordance with the manufacturer's recommendations and the Contract Documents. Materials used for support structures shall be suitable for the environment in which it is installed (corrosive - stainless steel, non corrosive - galvanized steel; unless indicated otherwise).

E. Where indicated on Drawings or as required for dual control, pressure switches shall have an adjustable deadband for setting separate open and close operating pressures. Minimum adjustable deadband setting shall be no greater than 20 psi.

F. Acceptable Manufacturers:
1. Ashcroft, L-series
2. United Electric Controls, 400 Series
3. Or equal

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Inspect each instrument and piece of equipment for defects, damage and correct operation before installation. Inspect work area and work involving other trades to verify readiness for installation.

B. Field instruments shall be installed per manufacturer's requirements. Verify that all mounting, process and electrical connections are secure and tight before operating instrument.

C. Install field instrument identification tag as described above.

D. The Contractor shall coordinate with the Mechanical Contractor to verify process connection type and location.

E. Field instruments installed in hazardous (classified) locations shall be installed in approved enclosures or electrically connected through an intrinsically safe barrier and shall meet all other requirements of NFPA 70 Articles 500-503.

F. Furnish and install sun shields for all analog instruments installed outdoors in direct sunlight where recommended by the instrument manufacturer.

G. Refer to Section 17500 for additional installation supervision, calibration, testing and start-up requirements.

END OF SECTION

SECTION 17520

LOCAL CONTROL PANELS

PART 1 -- GENERAL

1.01 SUMMARY

A. The I&C Contractor shall furnish all tools, equipment, materials, and supplies, and shall perform all labor as required for furnishing and installing Local Control Panel (LCP's) as indicated on the Drawings and as specified herein or in other Sections of the Specifications. Local control panels (LCP's) shall be designed to provide functionality and control as intended.

B. The following is a list of LCP's to be furnished under this Specification Section:

1. Filter Control Panel
2. Remote Terminal Unit (RTU)

C. The following is a list of existing RTU cabinets that are to be modified in compliance with the Drawings and this Specification Section:

1. ~~Aneth Well 2 RTU~~
2. ~~Aneth Well 3 RTU~~
3. Montezuma Creek Well 1 RTU
4. Montezuma Creek Well 2 RTU
5. Montezuma Creek Well 3 RTU

1.02 SUBMITTALS

A. Submit shop drawings in accordance with Section 17500.

B. Product Data: Submit manufacturer's data demonstrating compliance with specification requirements. Including enclosure, finish, control devices, relays, terminal blocks, wireway and accessories.

C. Product Data: Submit manufacturer's data demonstrating compliance with specification requirements. Including control devices, light kit, exhaust fan, surge arrester, receptacles, UPS, Ethernet switch, control relays, pilot lights, terminal blocks, DIN rails, plastic raceway and accessories.

D. Submit LCP wiring diagrams showing each and every wire in the panel and field wiring to the panel including each wire number and wire size. The wiring diagrams must indicate the terminal number at each device or terminal block where the wire is terminated, including field devices.

E. Submit interior component layout drawings of LCP's with component labels and bill of materials.

F. Submit exterior elevation drawings of LCP's with dimensions and device labels.

G. PLC/RTU cabinet wiring diagrams shall indicate wiring for each PLC input/output (I/O), including spare I/O. The wiring diagrams shall also indicate the I/O address point to be used in the PLC program.

H. Submit a block diagram of the distributed control and monitoring system network.

I. UPS: Submit UPS load calculations as described herein.

J. Power supplies: Submit load calculations with documentation indicating load of each component deriving power from the power supply to show that the total connected load does not exceed 50% of the power supply's capacity.

1.03 OPERATING AND MAINTENANCE MANUALS

A. Installation requirements and procedures.

B. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

C. Bill of Materials, component data sheets, descriptive literature, product specification sheets, wiring diagrams and calibration procedures. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

D. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

E. Refer to Specification Section 17500 for additional requirements.

1.04 QUALITY ASSURANCE

A. Equipment shall be designed and installed to conform to Drawings, Specifications, Engineering data, related equipment furnished by other suppliers and recommendations of the RTU manufacturer.

B. Design, construct and test according to the following Codes and Standards:

1. NEMA ICS-1, 2 & 3
2. NEMA (Testing Standards BU 1.3.03 or 1.304)
3. UL listing and labeling for materials.
4. NFPA-70
5. UL 508A

1.05 CONSTRUCTION STANDARDS

A. Each LCP shall be fabricated by a UL 508A recognized panel assembler and contain a serialized UL-508A label. All control panel components shall be UL Listed or UL Recognized under the category "Industrial Control Equipment".

1.06 RELATED WORK

A. Specification Section 17500 - General Instrumentation

B. Specification Section 17520 – Local Control Panels

C. Specification Section 17520 – NTUA Standard PLC Control Panel

D. Specification Section 17531 – Remote Terminal Unit (RTU)

PART 2 -- PRODUCTS

2.01 GENERAL

A. The I&C Contractor shall furnish the LCP(s) to satisfy the functional requirements specified in the relevant mechanical equipment, and Instrumentation & Control specification sections and as indicated on the Drawings. All components shall be UL labeled or provided with proper ground fault protection as required by UL 508A.

B. LCP enclosures shall be as indicated or described on the Drawings. Enclosures located outdoors shall be NEMA 3R and enclosures located indoors shall be NEMA 12, unless otherwise indicated. Each LCP enclosure shall contain a full size, steel back panel painted white for mounting components. LCP enclosures shall be ANSI 61 gray, unless otherwise indicated. LCP enclosures shall be steel with hinged doors. Freestanding enclosures shall have a 3-point latching handle. Outdoor enclosures with panel mounted devices shall contain a white interior swing panel.

2.02 TERMINAL BLOCKS

A. Each LCP shall be provided with identified terminal strips for the connection of all external conductors. There shall be sufficient terminal blocks for all external connections plus an additional 25 percent spare for future use. Terminal blocks shall be identified in accordance with approved shop drawings. Terminal blocks shall be individual, stacking, compression type, 600VAC, 30A minimum, suitable for wire sizes No. 10 - No. 18. A printed terminal block label shall be affixed to each terminal block for identification.

B. Each field-mounted device deriving power from the LCP shall be individually protected with a circuit breaker (Phoenix Contact TMC 1-M1 with N/C output contact) or fused terminal block (knife-blade or plug-in fuse) with blown fuse indicator.

C. Terminal blocks for analog signals shall be tiered style with built-in 3-stage surge protection for connection of a twisted shielded pair conductor including a separate ground connection. Analog signal terminal blocks shall be Phoenix Contact model TT-2PE-24DC or equal.

2.03 OPERATOR DEVICES

A. Pushbuttons, selector switches, and pilot lights shall be of the heavy-duty, oil-tight type, 30mm in size. Miniature style devices are not acceptable.

B. Pilot lights shall be push-to-test, LED style with LED and lens color as indicated on the Drawings.

C. START buttons shall have green cap and STOP buttons shall have red caps. All other button caps and selector switch operator handles shall be black. Pushbutton caps and selector switch operator handles shall be black.

D. Selector switches shall have the number of positions as indicated on the Drawings or as required to perform the intended function. Provide the number of 120VAC, 10A contacts as indicated on the Drawings or as required to perform the intended function.

E. Provide an engraved legend plate or provide laminated plastic nameplates as specified elsewhere for each device.

F. The operator devices shall have a NEMA rating equal to or more stringent than the control panel in which it is mounted.

G. Acceptable manufacturers:

1. Cutler-Hammer 10250 series
2. Square D 9001SK series
3. Or equal

2.04 CONTROL RELAYS

A. Control relays shall be DPDT (minimum) plug-in type utilizing rectangular blades with an indicating LED, and sockets with screw-type terminals and hold-down clips. Operating coil voltage shall be as required or indicated on the Drawings.

B. Contacts shall be rated 10 Amps at 120 VAC. Contact material shall be silver-cadmium oxide except for signal switching circuits that shall be gold plated or other noble metal.

C. Acceptable manufacturers

1. Square D Type K
2. IDEC Type RH
3. Or equal

2.05 TIMING RELAYS

A. Time delay relays shall be a combination on-delay and off-delay (selectable) with adjustable timing range from 1 sec to 10 hours. The timing relays shall include an LED indicator that is illuminated when the relay is timing out. Operating coil voltage rating shall be as indicated on the Drawings with DPDT, 120VAC, 10 amp rated contacts. Provide sockets with screw-type terminals and hold-down clips.

B. Reset Timers: Reset timers shall be synchronous motor driven with a solenoid-operated clutch. The timing relays shall include an LED indicator that is illuminated when the relay is timing out. Voltage rating shall be as indicated on

the Drawings with 120VAC, 10-amp rated contacts, and timing range as required or indicated on the Drawings.

C. Acceptable manufacturers:
   1. ATC
   2. IDEC
   3. Or equal

2.06 SURGE PROTECTIVE DEVICES

A. A 120VAC surge protective device (SPD) shall be installed on the 120V panel power supply as indicated on the Drawings.

B. The SPD unit shall be NEMA 4X rated, UL 1449 Third Edition Listed, pre-wired with conductor leads a minimum of 24-inches in length and contain LED indicator lights to indicate power is applied to the SPD and all is OK (Green).

C. The SPD unit shall be ANSI/IEEE C62.11, C62.41, C62.45 catelgories A, B, C3 tested.

D. Surge Current Capacity shall be 50kA minimum.

E. The SPD unit shall provide protection for all possible modes (L-N, L-G, N-G). Voltage Protection Rating (VPR) shall be 600V for 120VAC.

F. Warranty shall be for a minimum period of two years.

G. Acceptable manufacturers:
   1. Emerson
   2. Advanced Protection Technologies
   3. Or equal

2.07 POWER SUPPLIES

A. Power supplies shall be DIN-rail mounted and be of the solid-state circuitry type UL-1950 and CSA-1402C certified. Input power shall be 120VAC, ±10%, output voltage shall be as indicated on the Drawings or as required for proper operation of connected loads.

B. Power supplies shall be sized for 200% of the total connected load.

C. Line regulation shall be within ±0.05 percent with a 10 percent line change. Load regulation shall be within ±0.05 percent with a 50 percent load change. Output ripple shall not exceed 0.2 percent peak-to-peak. Transient response shall be less than 50 microseconds for a 50 percent load change.

D. Power supplies shall be fully rated with an efficiency of at least 60 percent for a temperature range of 0 - 60ºC or be oversized appropriately. Power supplies shall produce EMI/RFI noise levels within the requirements of FCC Docket 20780.

E. Power supplies shall contain internal short circuit and overload protection. Output fusing shall be supplied on the positive terminal.

F. Acceptable manufacturers:

1. Phoenix Contact Quint
2. No Equal

2.08 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. The UPS unit shall consist of a microprocessor controlled UPS control module and sealed, maintenance free, lead-acid batteries with automatic bypass switching upon input supply failure.

B. The UPS control module shall include built-in rectifier/battery charger, static transfer switch, and solid-state controls to provide a true sine-wave output. The UPS control module shall be housed in a rugged industrial grade enclosure.

C. Input voltage range: 22.5-30VDC.

D. Output power: 22.5-30VDC, 20A. Actual output rating of each UPS shall be as required to operate all loads being served for a minimum of 10 minutes without input power. UPS load calculations must be submitted with the UPS for approval.

E. UPS control module ambient temperature range: 0 - 60ºC

F. Batteries shall be sealed, maintenance-free type, designed for 5 years minimum service.

G. The UPS control module shall contain status LED's displaying the following as a minimum: UPS ready/buffering, UPS fault and low battery.

H. UPS shall be provided with dry contacts that close upon low battery alarm and input power loss.

I. The UPS control module shall be provided with a 2-year (minimum) warranty.

J. Acceptable manufacturers:

1. Phoenix Contact Mini Power
2. No Equal

2.09 TEMPERATURE SWITCHES

A. A temperature switch shall be provided for each RTU cabinet. Each switch shall be provided with a set of normally open, dry contacts that will close when room or enclosure temperature rises to the preset temperature. Each temperature switch shall be provided with an adjustable temperature range of 60 to 120 degrees Fahrenheit. Contact ratings shall be 5A minimum.

2.10 CABINET LIGHT AND RECEPTACLE

A. The RTU Cabinet and the Filter Control Panel shall be supplied with a 15A GFCI type convenience receptacle and single tube, fluorescent cabinet light with protective lamp shield. The cabinet light shall be controlled by a door activated switch that closes when the control panel door (inner door) is opened.

2.11 SPARE PARTS

A. Provide a minimum of 10 spare lamps.

B. Provide one control and one timing relay of each type utilized.

C. Provide one spare power supply of each size and type utilized.

D. Provide (3) spare fuses of each size and type utilized.

E. Refer to related specification sections for additional spare parts required.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Each PLC I/O point connected to an external device shall be terminated at terminal blocks. Where AC and DC signals must intercept each other, cross wires at 90° angles. Route AC and DC signals in separate wireways. Provide blank wireways for field wiring by the Contractor.

B. All internal wiring shall be contained in plastic raceways or troughs having removable covers. Wiring to door-mounted devices shall be extra flexible and anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent accidental contact with energized terminals.

C. Control panel conductors shall be stranded copper with 600V type MTW insulation. Minimum control panel conductor size for power shall be No.12 AWG. Minimum conductor size for control wiring shall be No. 14 unless protected by a 10A overcurrent protective device or smaller, in which case it can be No.16 AWG. Analog signal cables shall be 600V, No.16 AWG twisted shielded pair.

D. All conductors shall be labeled. Wire markers shall be heat shrinkable, be a minimum of 3/8-inches in length and placed as near as possible to the end of the wire. Orient wire marker such that the writing can be read without turning or twisting the wire.

E. Identification of panel-mounted devices control equipment enclosure shall be engraved laminated plastic with black letters on white background. Use minimum 3/16-inch letters for identifying individual panel components. Use minimum 3/8-inch letters for identifying control equipment enclosure.

F. LCP enclosure doors that contain 120VAC devices shall be bonded to the enclosure grounding lug.

G. All analog signals shall be individually fused at the terminal block. See additional requirements as specified elsewhere in these specifications.

3.02 INSTALLATION

A. LCP(s) shall be installed as indicated on the drawings. All front accessible panel-mounted devices shall be mounted a minimum of 42-inches above finished floor elevation.

B. LCP(s) shall be stored in an indoor, dry location at the jobsite to protect from condensation, damage, and the effects of weather.

C. LCP(s) interiors, and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the work.

D. See Section 17500 for additional installation requirements.

3.03 TESTING, STARTUP & TRAINING

A. LCP's shall be assembled and tested at the control panel shop for sequence of operation prior to jobsite delivery. An additional test shall be performed on site after all field wiring and external devices have been installed and connected. Coordinate with the Owner for PLC Programming and operator interface configuration installation.

B. Before LCP's can be shipped to the jobsite, a factory acceptance test must be successfully conducted at the control panel shop in the presence of the Engineer and Owner. The factory acceptance test will only be conducted after the PLC programming and operator interface configuration have been completed.

C. See additional testing, start-up and training requirements as specified elsewhere in these specifications.

SECTION 17520

NTUA STANDARD REMOTE TELEMETRY UNIT WIRING DIAGRAMS

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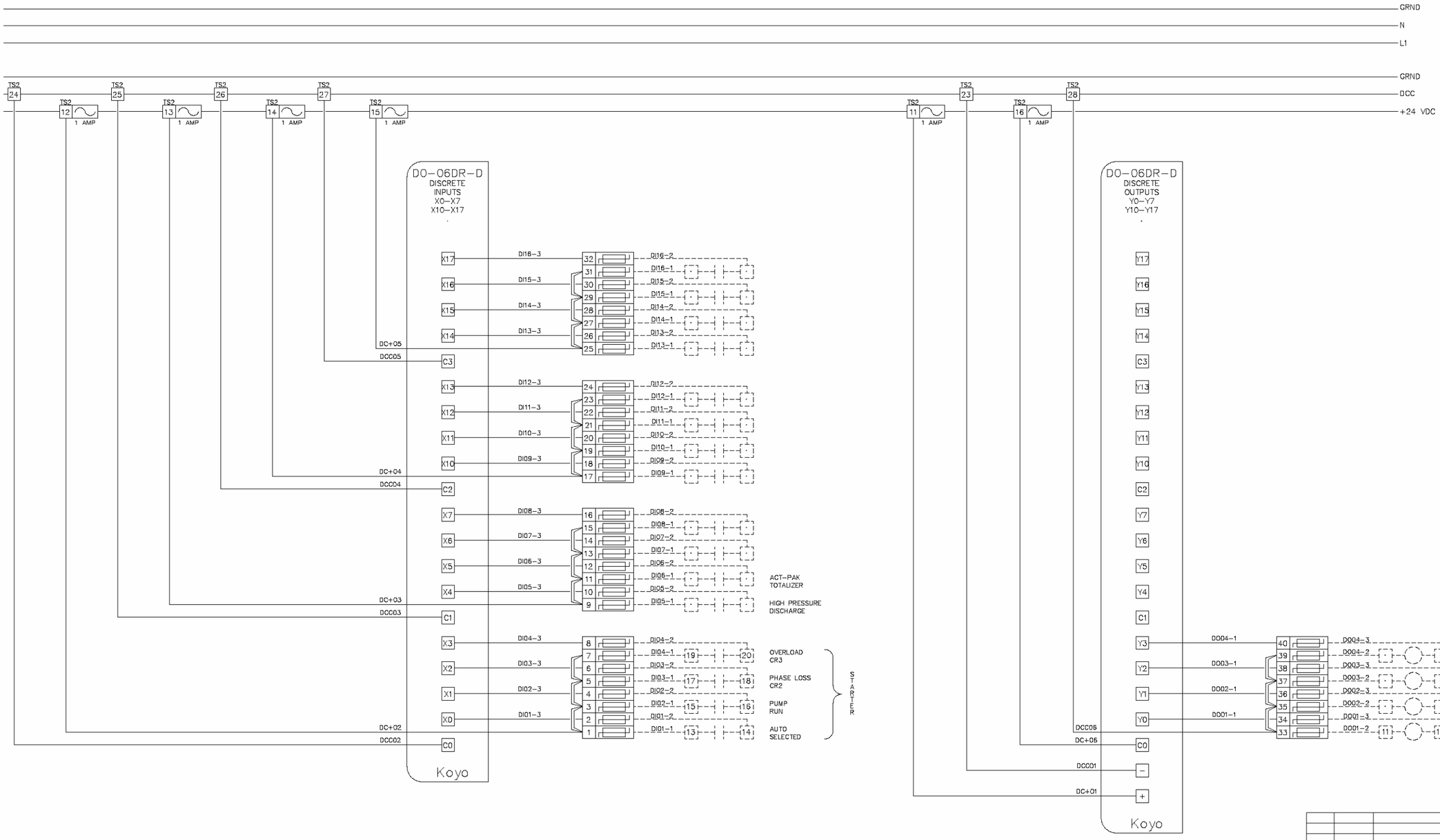


LECEND

Field Terminations ----------

Panel Wiring ----------

NO.	DATE	DESCRIPTION	BY
01	07/05	DWG UPDATES	NTUA

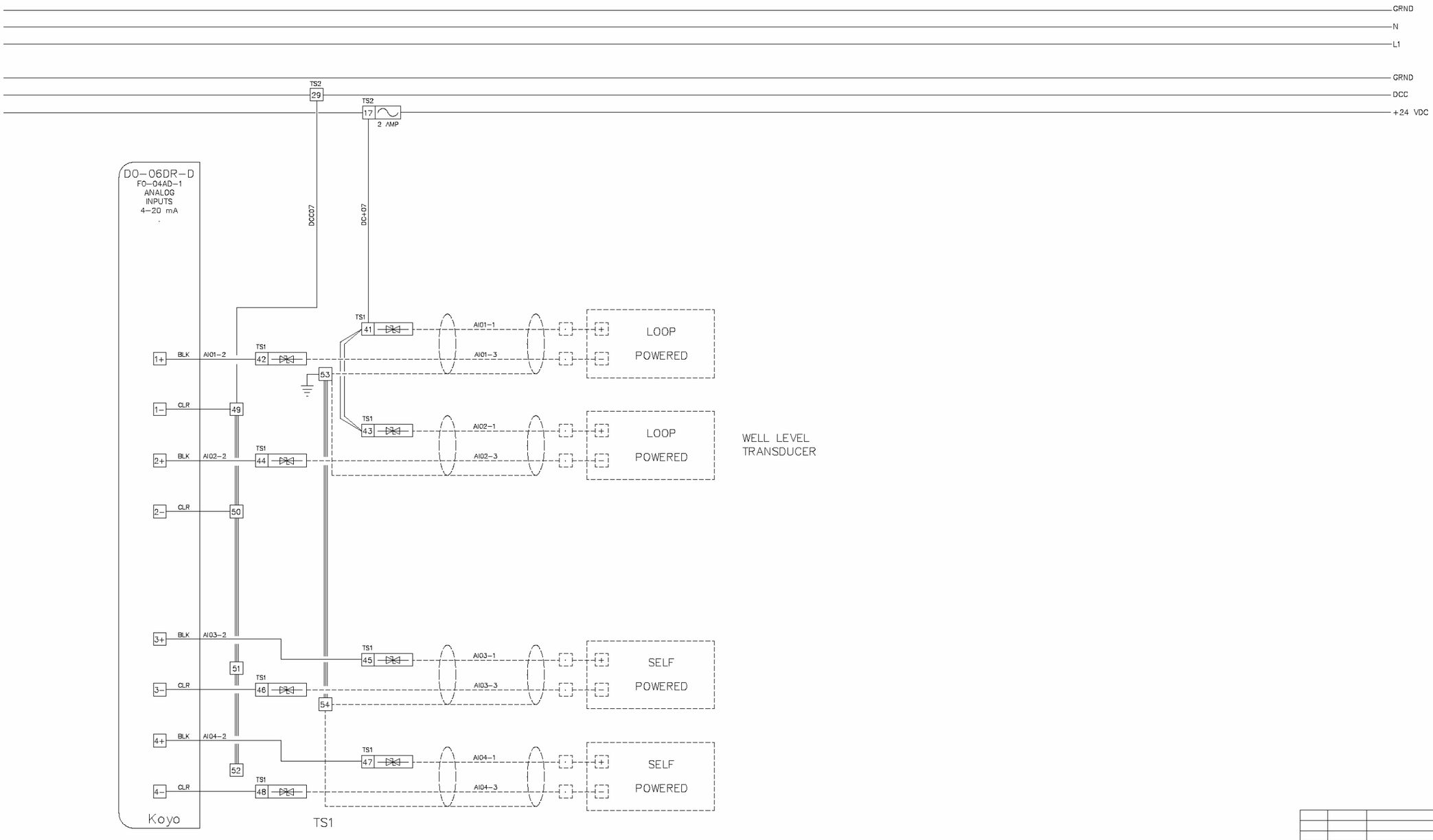
NAVAJO TRIBAL UTILITY AUTHORITY

SCALE: NONE	REVISIONS	BY	DATE
DATE: 9/1/98	.	.	.
DRN: . CKD: .	.	.	.
APVD: .			

TITLE: PLC CONTROL PANEL
DISCRETE I/O
(SIMPLEX WELL WITH MAG STARTER)

W.O.#

POWER DISTRIBUTION THIS PAGE REFLECTS "LOGICAL" SCHEMATIC SEE "DC DISTRIBUTION" DRAWING AND "AC DISTRIBUTION" DRAWING FOR POINT TO POINT TERMINATIONS



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Field Terminations ----------

Panel Wiring _____

NO.	DATE	DESCRIPTION	BY
01	07/05	DWG UPDATES	NTUA

NAVAJO TRIBAL UTILITY AUTHORITY

SCALE: NONE	REVISIONS	BY	DATE
DATE: .	.	.	.
DRN: . CKD: .	.	.	.
APVD: .			

TITLE: PLC CONTROL PANEL
ANALOG I/O
(SIMPLEX WELL WITH MAG STARTER)

DWG #

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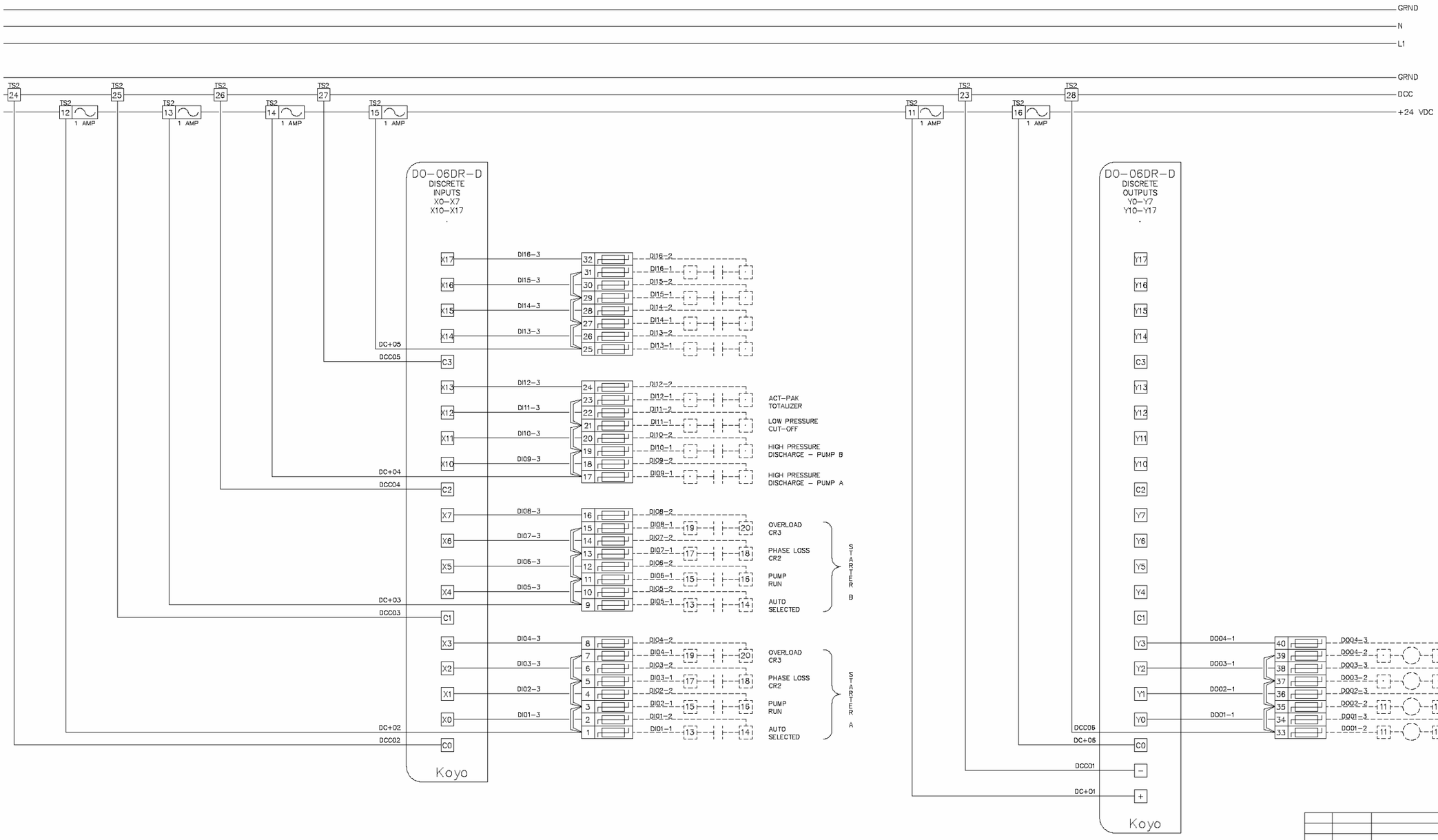

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Field Terminations ----------

Panel Wiring ----------

NO.	DATE	DESCRIPTION	BY
01	07/05	DWG UPDATES	NTUA

NAVAJO TRIBAL UTILITY AUTHORITY

SCALE: NONE	REVISIONS	BY	DATE
DATE: .	.	.	.
DRN: . CKD: .	.	.	.
APVD: .			

TITLE: PLC CONTROL PANEL
DISCRETE I/O
(BOOSTER WITH MAG STARTER)

DWG #

SHEET 2 OF 6

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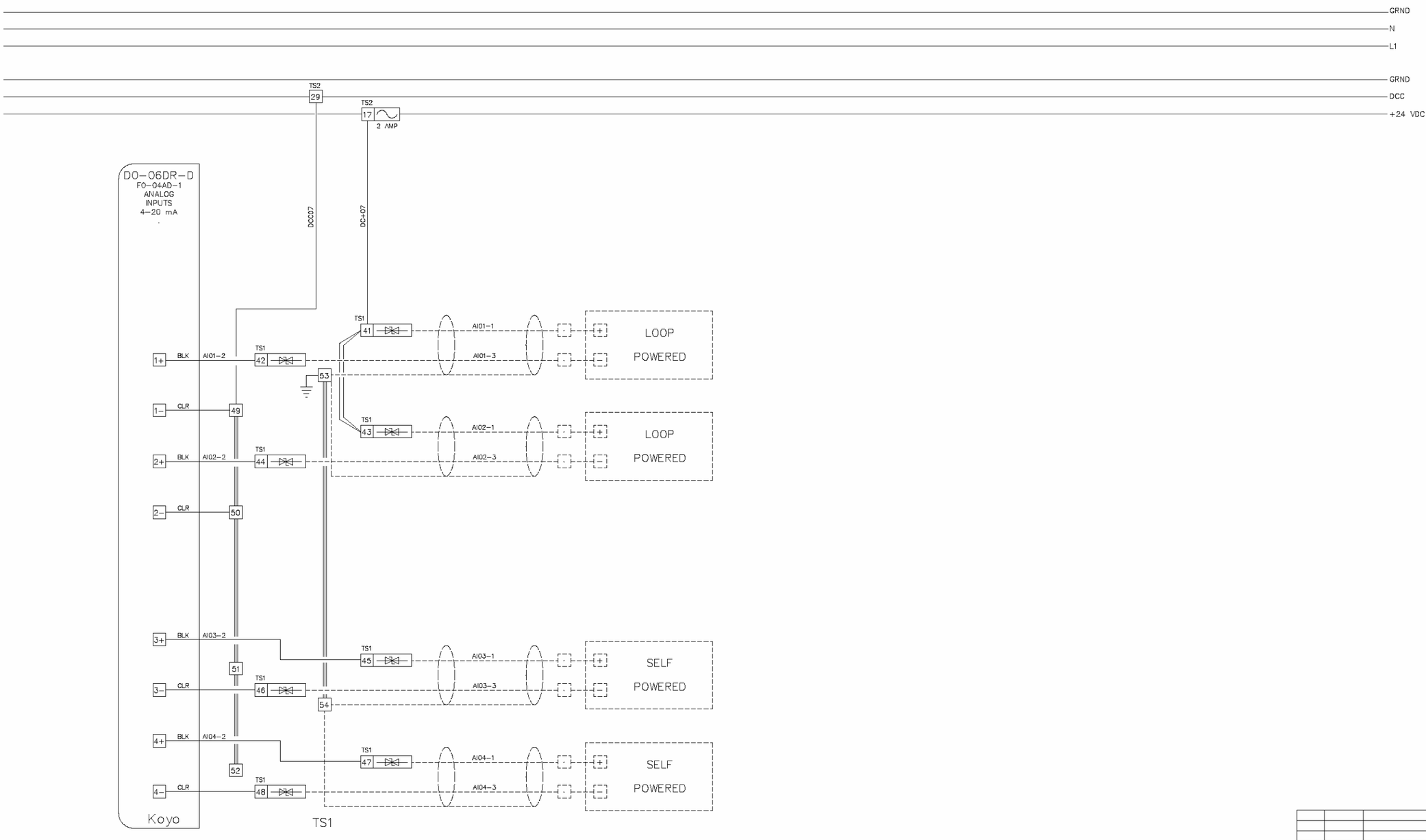


LEGEND

Field Terminations ----------

Panel Wiring _____

NO.	DATE	DESCRIPTION	BY
01	07/05	DWG UPDATES	NTUA

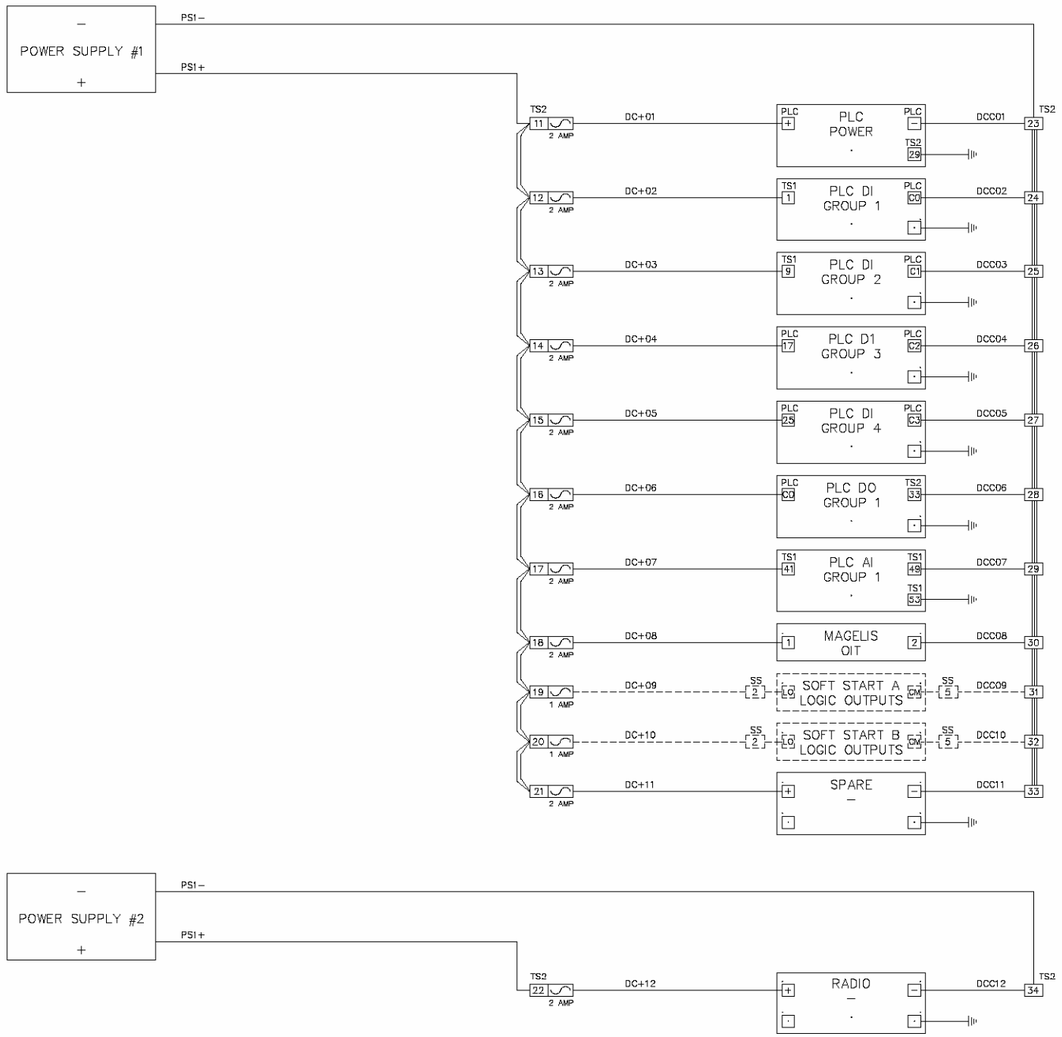
NAVAJO TRIBAL UTILITY AUTHORITY

SCALE: NONE	REVISIONS	BY	DATE
DATE: .	.	.	.
DRN: . CKD: .	.	.	.
APVD: .			

TITLE: PLC CONTROL PANEL
ANALOG I/O
(BOOSTER WITH MAG STARTER)

DWG #

24VDC DISTRIBUTION



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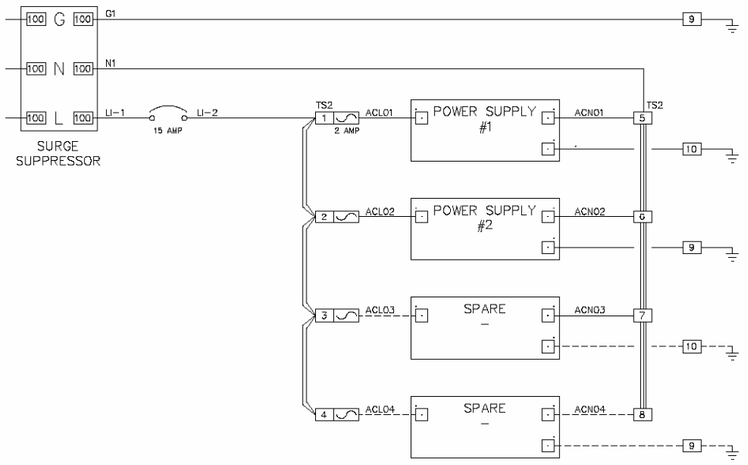
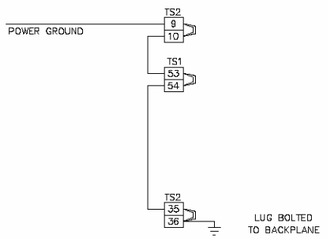


GRND



LECEND

Field Terminations ----------

Panel Wiring ——————

NO.	DATE	DESCRIPTION	BY
01	07/05	DWG UPDATES	NTUA

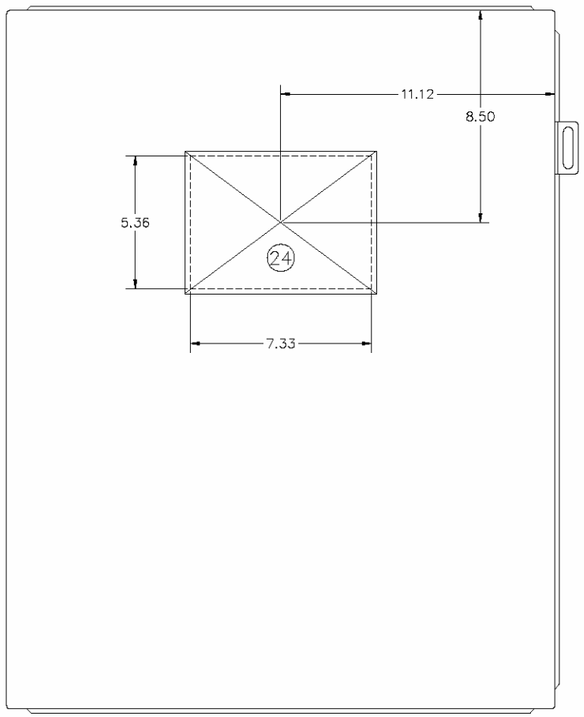
NAVAJO TRIBAL UTILITY AUTHORITY

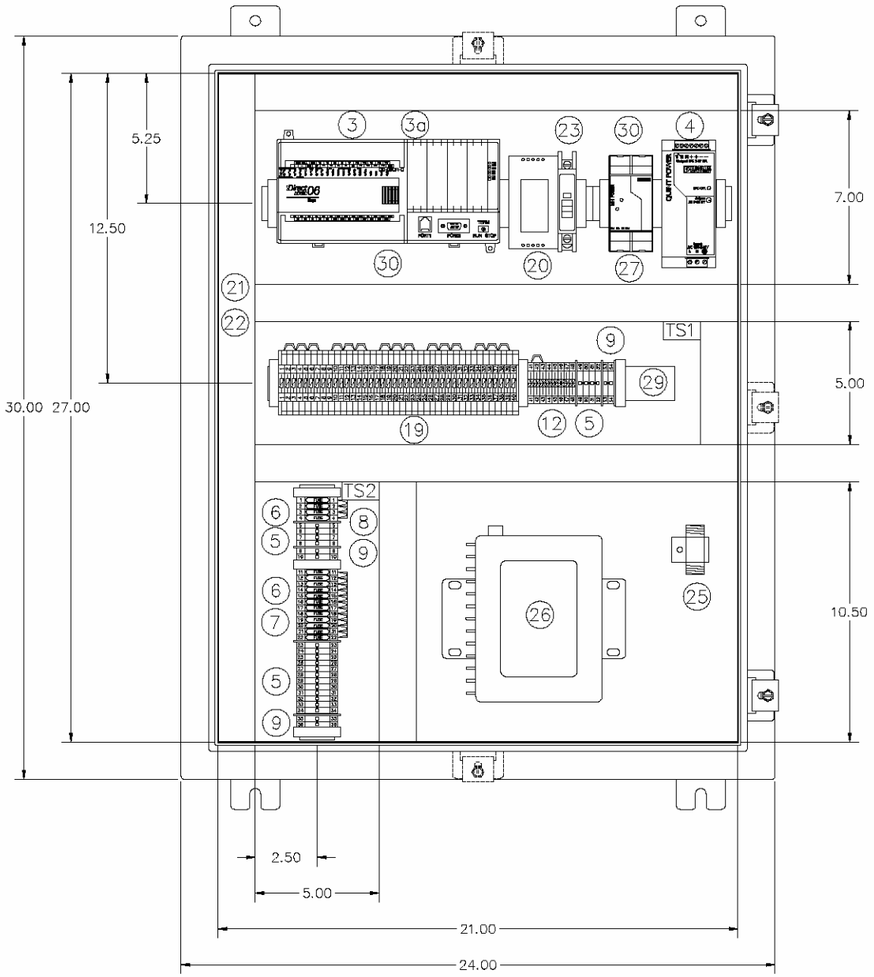
SCALE: NONE	REVISIONS	BY	DATE
DATE: .	.	.	.
DRN: . CKD. .	.	.	.
APVD. .			

TITLE: PLC CONTROL PANEL
POWER DISTRIBUTION

W.O.#

SHEET 4 OF 6





BILL OF MATERIALS

ITEM	QTY	PART NO.	DESCRIPTION	MFG
1	1	SCE-302410LP	SINGLE-DOOR TYPE 12 ENCLOSURE	SAGINAW
	or			
	1	A-302410LP	SINGLE DOOR TYPE 12 ENCLOSURE	HOFFMAN
2	1	SCE-30P24	BACKPLANE	SAGINAW
	or			
	1	A-30P24	BACKPLANE	HOFFMAN
3	.	D0-06DR-D	DIRECT LOGIC DL-06 PLC	KOYO
3a	1	F0-04AD-1	ANALOG INPUT MODULE	KOYO
4	1	QUINT-PS-100-240AC-24DC-5	POWER SUPPLY 22.5-28.5V ADJUSTABLE	PHOENIX CONTACT
5	20	UK5 N	UK5 N TERMINALS	PHOENIX CONTACT
6	16	UK4TG	FUSE TERMINAL BASE	PHOENIX CONTACT
7	12	ST-SILED24UK4	FUSE	PHOENIX CONTACT
8	4	ST-SILA250UK4	FUSE	PHOENIX CONTACT
9	6	USLKG5	GROUNDING TERMINAL	PHOENIX CONTACT
10	12	E/NS35N	END CLAMP	PHOENIX CONTACT
11	10	FB10-6 #0201184	FIXED BRIDGE	PHOENIX CONTACT
12	10	EB10-6 #0201139	INSERTION BRIDGE	PHOENIX CONTACT
13	10	D-UK4/10	END COVER	PHOENIX CONTACT
14	10	ATP-UK	PARTITION PLATES	PHOENIX CONTACT
15	3	DP-UKK3/5BK	SLKK5 SPACER PLATE	PHOENIX CONTACT
16	3	D-UKK3/5BK	SLKK5 ENDCOVER	PHOENIX CONTACT
17	8	UK 5/24 DC #2794699	TERMITRAB UK5 W/SUPPRESSOR DIODE	PHOENIX CONTACT
18	.	.	.	.
19	40	SLKK5 5/24VDC #2794903	TERMITRAB SLKK5 W/VARISTOR 24DC (MOV)	PHOENIX CONTACT
20	1	MT2PE/S120AC	TERMITRAB AC POWER PROTECTION	PHOENIX CONTACT
21	2	E1.5X4LG6	WIRING DUCT	PANDUIT
22	2	C1.5LG6	DUCT COVER	PANDUIT
23	1	QOU115	CIRCUIT BREAKER	SQUARE D
24	1	XBTF032110	5.7 GRAPHIC TERMINAL TOUCHSCREEN (MAGELIS)	SQUARE D
24a	1	.	CABLE - PLC TO GRAPHIC TERMINAL	.
*25	1	IS-50NX-C2	LIGHTNING ARRESTER	POLYPHASER
26	1	9810	902 - 928 MHz RADIO	ADAPTIVE BROADBAND
	or			
	1	4710	380 - 512 MHz RADIO	ADAPTIVE BROADBAND
27	1	MINI-PS-100-240AC/10-15DC/2	POWER SUPPLY 10-15V ADJUSTABLE	PHOENIX CONTACT
28	.	.	.	.
29	3	1492DR6	EXTENDED DIN RAIL	ALLEN BRADLEY
30	1	1492-DR5	DIN RAIL	ALLEN BRADLEY
31	1	.	CABLE - PLC TO MODEM (TO LENGTH)	.

NO.	DATE	DESCRIPTION	BY
01	07/05	MATERIALS LIST & DWG UPDATES	NTUA

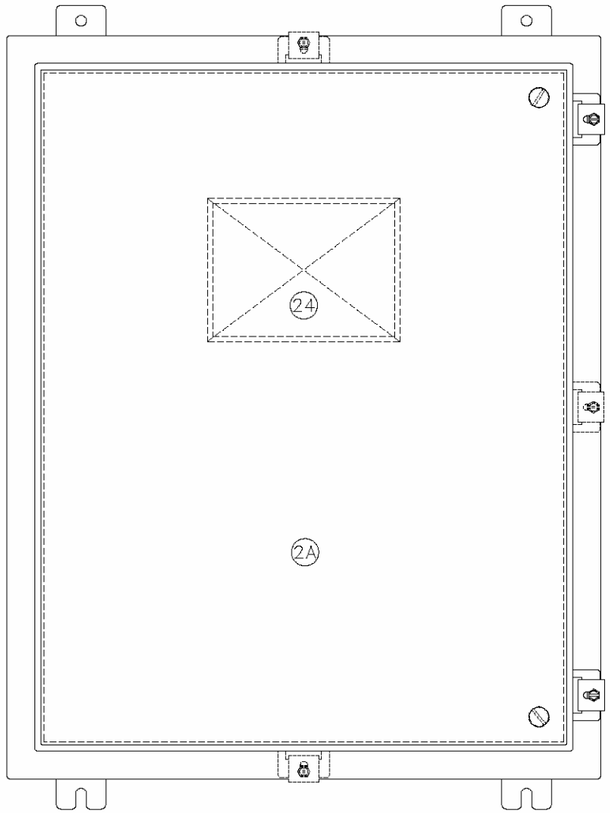
NAVAJO TRIBAL UTILITY AUTHORITY

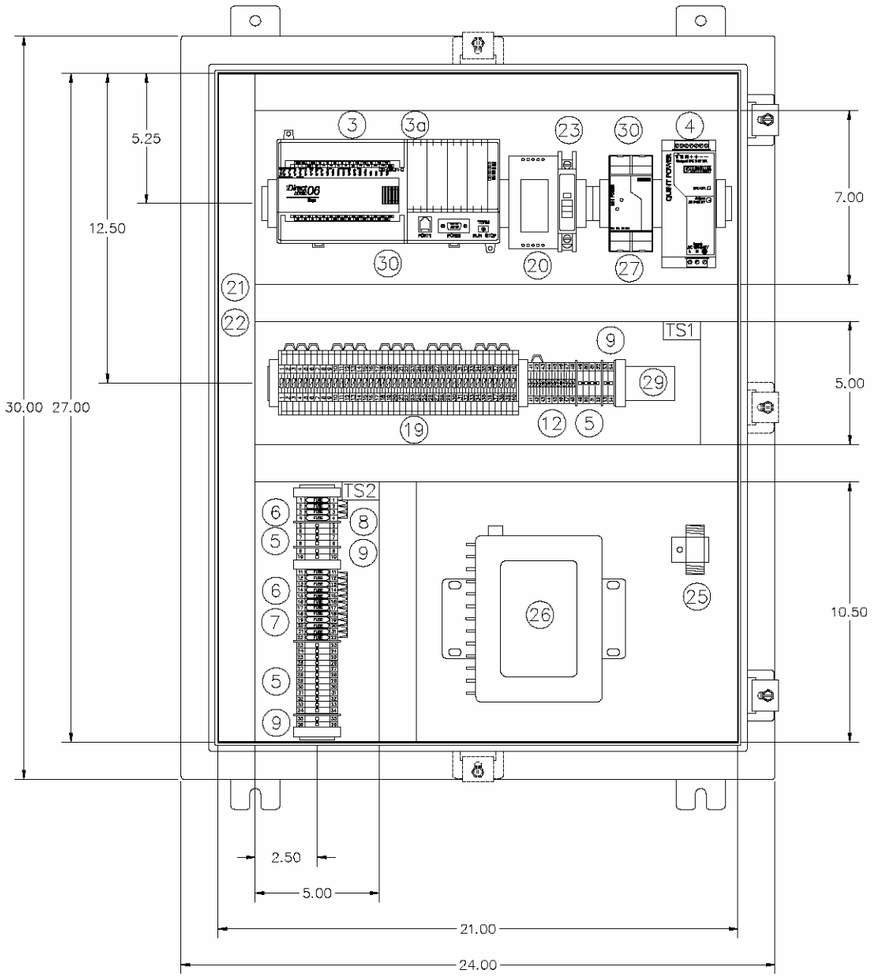
		REVISIONS	BY	DATE
SCALE: NONE		.	.	.
DATE: 9/1/98	CKD. .	.	.	.
DRN: .				
APVD. .				

TITLE: PLC CONTROL PANEL
BACKPLANE

W.O.#

SHEET 5 OF 6





BILL OF MATERIALS

ITEM	QTY	PART NO.	DESCRIPTION	MFG
1	1	SCE-30H24CLP	SINGLE-DOOR TYPE 4 ENCLOSURE	SAGINAW
	or			
	1	A-30H24CLP	SINGLE DOOR TYPE 4 ENCLOSURE	HOFFMAN
2	1	SCE-30P24	BACKPLANE	SAGINAW
	or			
	1	A-30P24	BACKPLANE	HOFFMAN
2a	1	SCE-NADFK	SWING OUT PANEL KIT	SAGINAW
	or			
	1	A-NADFK	SWING OUT PANEL KIT	HOFFMAN
3	.	D0-06DR-D	DIRECT LOGIC DL-06 PLC	KOYO
3a	1	F0-04AD-1	ANALOG INPUT MODULE	KOYO
4	1	QUINT-PS-100-240AC-24DC-5	POWER SUPPLY 22.5-28.5V ADJUSTABLE	PHOENIX CONTACT
5	20	UK5 N	UK5 N TERMINALS	PHOENIX CONTACT
6	16	UK4TG	FUSE TERMINAL BASE	PHOENIX CONTACT
7	12	ST-SILED24UK4	FUSE	PHOENIX CONTACT
8	4	ST-SILA250UK4	FUSE	PHOENIX CONTACT
9	6	USLKG5	GROUNDING TERMINAL	PHOENIX CONTACT
10	12	E/NS35N	END CLAMP	PHOENIX CONTACT
11	10	FB10-6 #0201184	FIXED BRIDGE	PHOENIX CONTACT
12	10	EB10-6 #0201139	INSERTION BRIDGE	PHOENIX CONTACT
13	10	D-UK4/10	END COVER	PHOENIX CONTACT
14	10	ATP-UK	PARTITION PLATES	PHOENIX CONTACT
15	3	DP-UKK3/5BK	SLKK5 SPACER PLATE	PHOENIX CONTACT
16	3	D-UKK3/5BK	SLKK5 ENDCOVER	PHOENIX CONTACT
17	8	UK 5/24 DC #2794699	TERMITRAB UK5 W/SUPPRESSOR DIODE	PHOENIX CONTACT
18	.	.	.	.
19	40	SLKK5 5/24VDC #2794903	TERMITRAB SLKK5 W/VARISTOR 24DC (MOV)	PHOENIX CONTACT
20	1	MT2PE/S120AC	TERMITRAB AC POWER PROTECTION	PHOENIX CONTACT
21	2	E1.5X4LG6	WIRING DUCT	PANDUIT
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23	1	QOU115	CIRCUIT BREAKER	SQUARE D
24	1	XBTF032110	5.7 GRAPHIC TERMINAL TOUCHSCREEN (MAGELIS)	SQUARE D
24a	1	.	CABLE - PLC TO GRAPHIC TERMINAL	.
25	1	IS-50NX-C2	LIGHTNING ARRESTER	POLYPHASER
26	1	9810	902 - 928 MHz RADIO	ADAPTIVE BROADBAND
.	or 1	4710	380 - 512 MHz RADIO	ADAPTIVE BROADBAND
27	1	MINI-PS-100-240AC/10-15DC/2	POWER SUPPLY 10-15V ADJUSTABLE	PHOENIX CONTACT
28	1	.	.	.
29	3	1492DR6	EXTENDED DIN RAIL	ALLEN BRADLEY
30	1	1492-DR5	DIN RAIL	ALLEN BRADLEY
31	1	.	CABLE - PLC TO MODEM (TO LENGTH)	.

NO.	DATE	DESCRIPTION	BY
01	07/05	MATERIALS LIST & DWG UPDATES	NTUA

NAVAJO TRIBAL UTILITY AUTHORITY

SCALE: NONE	REVISIONS	BY	DATE
DATE: .	.	.	.
DRN: . CKD: .	.	.	.
APVD: .			

TITLE: PLC CONTROL PANEL W/ SWING OUT PANEL

DWG #

SHEET 5A OF 6

END OF SECTION

SECTION 17530

PROGRAMMABLE LOGIC CONTROLLERS (PLC)

PART 1 -- GENERAL

1.01 SUMMARY

A. This section includes the furnishing and installation of Programmable Logic Controllers (PLC's) for each Filter Control Panel consisting of a PLC, operator interface terminal (OIT), power supplies, interconnecting cables and all associated components for control and monitoring of equipment as indicated on the Drawings and as specified herein.

B. This section also includes the furnishing and installation of PLC's to replace the existing Direct Logic PLC's in each existing NTUA remote terminal unit (RTU) at the following sites.

1. ~~Aneth Well 2~~
2. ~~Aneth Well 3~~
3. Montezuma Creek Well 1
4. Montezuma Creek Well 2
5. Montezuma Creek Well 3

C. The Contractor shall coordinate the installation and wiring of each PLC with the I&C Contractor, Owner, Engineer, and make provisions for on-site start-up and testing of the PLC's.

1.02 SUBMITTALS

A. Manufacturer's catalog cut sheets indicating electrical characteristics, capabilities and physical attributes for each PLC component including PLC, OIT, CPU, power supplies, I/O modules, special interface modules or devices, module racks, interconnecting cables and any other equipment related to the PLC.

B. A tabular list must be submitted for all discrete and analog I/O which will include:

1. Rack number, module number, module I/O point number.
2. Name of each I/O field device.
3. Instrument tag number of the I/O device located in the contract documents.
4. Electrical characteristics of I/O signal.
5. PLC internal address.

C. Include a list of I/O being monitored and controlled from any human-machine interface (HMI) such as an OIT and/or SCADA computer.

1.03 OPERATING AND MAINTENANCE MANUALS

A. Installation requirements and procedures.

B. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

C. Bill of Materials, component data sheets, descriptive literature, product specification sheets, wiring diagrams and calibration procedures. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

D. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

E. Refer to Specification Section 17500 for additional requirements.

1.04 QUALITY ASSURANCE

A. Equipment shall be designed and installed to conform to Drawings, Specifications, Engineering data, related equipment furnished by other suppliers and recommendations of the RTU manufacturer.

B. Design, construct and test according to the following Codes and Standards:

1. NEMA ICS-1, 2 & 3
2. UL 508A
3. NFPA-70.

1.05 RELATED WORK

A. Specification Section 17500 - General Instrumentation

B. Specification Section 17520 - Local Control Panels

1.06 SYSTEM OVERVIEW

A. Filter Control Panel PLC's with their associated components provide logic for monitoring and control of their respective arsenic treatment systems as indicated on the Drawings and as described in these Specifications.

B. Well site PLC's with their associated components provide logic for monitoring and control of their respective well pumps.

PART 2 -- PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER

A. General

1. The PLC(s) shall be furnished with hardware, software, cables, connectors, adapters, operation and maintenance manuals necessary to monitor and control equipment as intended by these Construction Documents.

B. PLC Programming Software

1. The PLC programming software shall enable the user to write the PLC program in on-line or off-line modes.
2. The software shall include utilities to manage PLC program files, document and print the programs, configure the programming environment, monitor and force the PLC addresses while on-line, and configure the PLC memory and addressing structure.
3. One copy of the PLC programming software shall be provided with the user's manuals, original diskettes, and licensing agreement for registration by the Owner.

C. Central Processing Unit (CPU)

1. The CPU shall be a microprocessor based industrial controller with a temperature rating of 0 to 60 degrees C and a humidity rating of 0 to 95 percent non-condensing, minimum.
2. Memory (RAM) shall be sized as required for all system logic and control functions with a minimum of 50 percent spare capacity. RAM shall be protected by lithium battery backup for at least one year, and capacitor storage for up to two weeks.
3. The CPU shall be programmable using conventional ladder-type and function block logic.
4. The CPU shall be able to perform the following functions:
    a. Data comparisons
    b. On-delay and Off-delay Timers
    c. Counters
    d. Master Control Relays
    e. Transitional or one-shot outputs
    f. PID loop control
    g. Floating point math
5. The CPU shall be provided with internal fault analysis with a fail-safe mode and output for remote failure alarming. A minimum of two communication ports shall be provided on the CPU. One port shall be utilized for a peer-to-peer network connection as indicated on the Plans. A second communication port shall be used for connection to an Operator's interface or other peripheral devices as indicated on the Drawings.

D. Communication Modules

1. Furnish PLC with communication module(s) as required to communicate with other peripheral devices as indicated on the Drawings.

E. I/O Modules

1. Each field input and output shown as an I/O point shall be connected per the manufacturer's requirements and recommendations.

2. The I/O module chassis shall include a minimum of 20% blank back panel space for future I/O modules. Each empty slot shall be provided with an empty slot filler card. PLC rack shall include the appropriate end caps.

3. Discrete input modules shall be plug-in, rack style modules with 24V DC rated inputs and shall have LED indicators for each point displaying the status of the field contact. A maximum of sixteen (16) isolated dry contact type discrete inputs shall be provided per module. Provide a minimum of 20 percent spare points wired to terminal blocks.

4. Discrete output modules shall be plug-in, rack style modules with a source voltage output having a current rating of 0.5A at 24V DC, minimum. Outputs shall have LED indicators for each output status. Each output shall drive an interposing relay with DPDT contacts rated 10A at 120 VAC. A maximum of sixteen (16) isolated dry contact type discrete outputs shall be provided per module. Provide a minimum of 10 percent spare points complete, wired to interposing relays and terminal blocks.

5. Analog input modules shall be plug-in, rack style modules which will accept 4-20Ma DC signals. Input circuitry shall provide differential input (no common) to prevent loop grounding problems. Analog to digital conversion shall have 12 bit resolution or greater. A maximum of eight (8) isolated analog inputs shall be provided per module. Provide a minimum of 10 percent spare points wired to terminal blocks.

6. Analog output modules shall be plug-in, rack style modules which transmit isolated linear 4-20Ma DC signals to field devices. Loop power for analog outputs shall be provided by regulated power supplies each capable of driving a 0-600 Ohm load. Digital to analog conversion shall have 12 bit resolution or greater. A maximum of eight (8) isolated analog outputs shall be provided per module. Provide a minimum of 10 percent spare points wired to terminal blocks.

F. PLC Power Supply

1. The PLC power supply shall be rack mounted and shall be of the same manufacturer as the PLC.

2. The PLC power supply shall be sized as required with an additional 50% spare capacity. Power supply calculations shall be furnished to verify power supply rating selected.

G. Acceptable Manufacturers

1. Modicon M340

2. No equal

2.02 OPERATOR INTERFACE TERMINAL (OIT)

A. The OIT shall include a communication port for connection to the PLC as indicated on the Drawings.

B. The operator interface shall be furnished with hardware, cables, software, operation and maintenance manuals as necessary.

C. Acceptable Manufacturers

1. Schneider Magelis GTO
2. No equal

2.03 NETWORKING COMPONENTS

A. Ethernet Switch

1. Five 10/100Base TX RJ-45 ports.
2. Fully IEEE 802.1 compliant.
3. Auto detecting 10BaseT/100BaseTX, Duplex, MDIX.
4. Fully managed.
5. Mounting: DIN rail.
6. Power: 24VDC
7. UL listed.
8. Acceptable manufacturers:
    a. Phoenix Contact FL SWITCH SFN
    b. Or equal

2.04 SPARE PARTS

A. Provide one spare PLC power supply.

B. Provide one spare PLC CPU.

C. Provide one spare I/O module of each type utilized.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The PLC's shall be installed as indicated on the Drawings and in accordance with the manufacturer's recommendations and requirements. Each PLC I/O point connected to an external device shall be terminated at terminal blocks. Where AC and DC signals must intercept each other, cross wires at 90 degree angles. Route AC and DC signals in separate wireways. Provide blank wireways for field wiring by the Contractor.

B. All analog input and output signals shall be individually fused at the terminal block. See additional requirements as specified elsewhere in these specifications.

C. Upon completion of installation, start-up shall be performed by the I&C Contractor and witnessed by the Engineer and/or Owner. See additional requirements as specified elsewhere in these specifications.

D. The PLC program, operator interface graphical screens and I/O shall be thoroughly tested. Each input and output signal shall be tested for correct indication and control function. The Contractor shall coordinate with the Owner for PLC programming and operator interface configuration installation. See additional requirements as specified elsewhere in these specifications.

E. Managed Ethernet switches shall be fully configured.

END OF SECTION

SECTION 17531

REMOTE TERMINAL UNIT (RTU)

PART 1 -- GENERAL

1.01 SUMMARY

A. This section includes the furnishing and installation of a Remote Terminal Unit (RTU) consisting of a Programmable Logic Controller (PLC), operator interface terminal (OIT), radio modem, antenna, antenna mast, power supplies, interconnecting cables and all associated components for control and monitoring of equipment per NTUA standards and as specified herein.

B. The Contractor shall coordinate the installation and wiring of the RTU with the I&C Contractor, Engineer, and make provisions for on-site start-up and testing of the RTU.

1.02 SUBMITTALS

A. Manufacturer's catalog cut sheets indicating electrical characteristics, capabilities and physical attributes for each RTU component including PLC, OIT, CPU, power supplies, I/O modules, special interface modules or devices, module racks, radio modem, antenna, antenna mast, interconnecting cables and any other equipment related to the RTU.

B. A tabular list must be submitted for all discrete and analog I/O which will include:

1. Rack number, module number, module I/O point number.
2. Name of each I/O field device.
3. Instrument tag number of the I/O device located in the contract documents.
4. Electrical characteristics of I/O signal.
5. PLC internal address.

Include a list of I/O being monitored and controlled from the operator interface terminal (OIT) and/or SCADA computer.

1.03 OPERATING AND MAINTENANCE MANUALS

A. Installation requirements and procedures.

B. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

C. Bill of Materials, component data sheets, descriptive literature, product specification sheets, wiring diagrams and calibration procedures. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

D. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***

E. Refer to Specification Section 17500 for additional requirements.

1.04 QUALITY ASSURANCE

A. Equipment shall be designed and installed to conform to Drawings, Specifications, Engineering data, related equipment furnished by other suppliers and recommendations of the RTU manufacturer.

B. Design, construct and test according to the following Codes and Standards:

1. NEMA ICS-1, 2 & 3
2. UL 508A
3. NFPA-70.

1.05 RELATED WORK

A. Specification Section 17500 - General Instrumentation

B. Specification Section 17520 – Local Control Panels

C. Specification Section 17520 – NTUA Standard PLC Control Panel

1.06 SYSTEM OVERVIEW

A. The RTU with its associated components provide logic for monitoring and control of the system as indicated on the Drawings and as described in these Specifications.

PART 2 -- PRODUCTS

2.01 RTU CABINET

2.02 PROGRAMMABLE LOGIC CONTROLLER

A. General

1. The PLC(s) shall be furnished with hardware, software, cables, connectors, adapters, operation and maintenance manuals necessary to monitor and control equipment as intended by these Construction Documents.

B. PLC Programming Software

1. The PLC programming software shall enable the user to write the PLC program in on-line or off-line modes.
2. The software shall include utilities to manage PLC program files, document and print the programs, configure the programming environment, monitor and force the PLC addresses while on-line, and configure the PLC memory and addressing structure.

3. One copy of the PLC programming software shall be provided with the user's manuals, original diskettes, and licensing agreement registered in the Owner's name.

C. Central Processing Unit (CPU)

1. The CPU shall be an Modicon model M340.
2. Memory (RAM) shall be sized as required for all system logic and control functions with a minimum of 50 percent spare capacity. RAM shall be protected by lithium battery backup for at least one year, and capacitor storage for up to two weeks.
3. A minimum of two Modbus TCP/IP communication ports and one USB programming port shall be provided on the CPU.

D. Communication Modules

1. Furnish PLC with communication module(s) as required to communicate with other peripheral devices as indicated on the Drawings.

E. I/O Modules

1. Each field input and output shown as an I/O point shall be connected per the manufacturer's requirements and recommendations.
2. Discrete input modules shall comply with the module specified in the NTUA Standard PLC Control Panel. Provide a minimum of 20 percent spare points wired to terminal blocks.
3. Discrete output modules shall comply with the module specified in the NTUA Standard PLC Control Panel. Provide a minimum of 10 percent spare points complete, wired to interposing relays and terminal blocks.
4. Analog input modules shall comply with the module specified in the NTUA Standard PLC Control Panel. Provide a minimum of 10 percent spare points wired to terminal blocks.
5. Analog output modules shall comply with the module specified in the NTUA Standard PLC Control Panel. Provide a minimum of 10 percent spare points wired to terminal blocks.

F. PLC Power Supply

1. The PLC power supply shall be rack mounted and shall be of the same manufacturer as the PLC.
2. The PLC power supply shall be sized as required with an additional 50% spare capacity. Power supply calculations shall be furnished to verify power supply rating selected.
3. Refer to the NTUA Standard PLC Control Panel for additional power supply requirements.

2.03 OPERATOR INTERFACE TERMINAL (OIT)

A. The OIT shall be a Schneider Magelis GTO

B. The OIT shall include a communication port for connection to the PLC as indicated on the Drawings.

C. The operator interface shall be furnished with hardware, cables, software, operation and maintenance manuals as necessary.

D. A minimum of five (5) graphic screens shall be developed to display and control the system I/O as indicated on the Drawings and described in Section 17550.

1. The displays shall be reviewed during the submittal review process and again during startup and testing. If modifications are deemed necessary by the Engineer, the Contractor shall make modifications at no cost to the Owner.

E. Refer to the NTUA Standard PLC Control Panel for additional information.

2.04 ETHERNET SWITCH

A. The make and model of the Ethernet switch shall be Phoenix Contact FL SWITCH SFN. The total number of ports shall be a minimum of five (5) 10/100Base TX RJ-45 ports.

B. Refer to the NTUA Standard PLC Control Panel for additional information.

2.05 RADIO TELEMETRY COMPONENTS

A. The make and model of the 900-928 Mhz radio modem shall be GE MDS Orbit or TransNet with DIN rail mounting kit.

B. Antenna mast and grounding as indicated on the Drawings.

C. Stainless steel antenna mounting hardware as required for mounting to the antenna mast.

D. 900MHz Wireless RTU components shall be Phoenix Contact Radioline or equal.

E. Polyphaser IS-50NX-C2 antenna feedline surge suppressor.

F. Andrew LDF4-50A ½" antenna feedline.

G. Andrew 241088-1 grounding strap and weatherproofing kit for ½" antenna feedline.

H. Refer to the NTUA Standard PLC Control Panel for additional information.

2.06 SPARE PARTS

A. Provide one spare CPU.

B. Provide one spare PLC power supply.

C. Provide one spare I/O module of each type utilized.

D. Provide one spare communication module of each type utilized.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The RTU shall be installed as indicated on the Drawings and in accordance with the manufacturer's recommendations and requirements. Each PLC I/O point connected to an external device shall be terminated at terminal blocks. Where AC and DC signals must intercept each other, cross wires at 90 degree angles. Route AC and DC signals in separate wireways. Provide blank wireways for field wiring by the Contractor.

B. All spare I/O shall be wired to terminal blocks for future use. Spare discrete output points shall be wired to interposing relays and then to the terminal blocks.

C. All analog input and output signals shall be individually fused at the terminal block. See additional requirements as specified elsewhere in these specifications.

D. Install a copper grounding conductor with green insulation between antenna grounding kit and ground system as indicated on the Drawings. Provide exothermic weld for each ground connection.

E. Install antenna mast and antenna as indicated on the Drawings.

F. Upon completion of installation and all field wires terminated, the Contractor shall thoroughly test the RTU for proper operation with all field wiring terminated. Each input and output signal shall be tested for correct indication and control function. When the Contractor is satisfied that the system performs as intended by these Contract Documents, the Contractor shall call for an official start-up. System start-up shall be performed by the Contractor with the I&C Contractor and Programmer present and witnessed by the Engineer and/or Owner. See additional requirements as specified elsewhere in these specifications.

G. Coordinate with the Owner for establishing communication with the existing reservoir site.

3.02 TRAINING

A. There are no training requirements for this item.

END OF SECTION