SEALS PAGE

DIVISION 100-900 SPECIFICATIONS

INDIAN HEALTH SERVICE &
NAVAJO ENGINEERING CONSTRUCTION AUTHORITY
LEUPP-DILKON WATER SUPPLY SYSTEM

SPECIFICATIONS	PREPARED BY
Division 100-900	
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SEALS PAGE

DIVISION 16 & 17 SPECIFICATIONS

INDIAN HEALTH SERVICE &

NAVAJO ENGINEERING AND CONSTRUCTION AUTHORITY

LEUPP-DIKON WATER SUPPLY SYSTEM

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Leupp-Dilkon Water Transmission Project
Technical Specifications Index
Prepared for Indian Health Services
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Technical Specification

101 SUBMITTAL PROCEDURES
102 PROGESS SCHEDULE
105 PROTECTED SPECIES
106 PRESERVATION OF HISTORICAL AND ARCHAELOGICAL DATA
107 STORM WATER POLLUTION PREVENTION
108 WATER POLLUTION CONTROL

201 GENERAL EARTHWORK
202 CLEARING AND GRUBBING
203 TRENCHING, EXCAVATION, AND BACKFILLING
204 FILL MATERIALS
205 EROSION CONTROL
206 GEOTEXTILE FABRIC AND GEOGRIDS

301 CAST-IN-PLACE CONCRETE
302 CONCRETE FORMWORK
303 MASONRY
304 CURB & GUTTER, SIDEWALKS, DRIVE PAD, AND CONCRETE PAVEMENT CONSTRUCTION

402 BASE COURSE MATERIAL
404 GRAVEL ROADS AND DRIVEWAYS

501 WATER LINES AND APPURTENANCES
502 CONCRETE VAULTS AND MANWAYS
503 STATION VALVES, PIPING, APPURTENANCES, AND ASSOCIATED PAINTING
505VC VERTICAL CENTRIFUGAL PUMP SKIDS
506B HYDROPNEUMATIC BLADDER SURGE CONTROL SYSTEM
509 CHLORINATION EQUIPMENT

606 SLAB TRENCH DRAINS

Technical Specification

701 STATION BUILDINGS
702 FENCING
704 HOIST, BRIDGE CRANE

901 DESIGN CODES AND REFERENCES

Electrical Specification

SECTION 16000 GENERAL REQUIREMENTS FOR ELECTRICAL WORK
SECTION 16030 ELECTRICAL ACCEPTANCE TESTING
SECTION 16155 INDIVIDUAL MOTOR STARTERS
SECTION 16231 OUTDOOR STANDBY DIESEL-ENGINE GENERATOR
SECTION 16260 AUTOMATIC TRANSFER SWITCHES
SECTION 16431 ARC FLASH ANALYSIS, SHORT CIRCUIT STUDY, AND PROTECTIVE DEVICE COORDINATION REPORT
SECTION 17000 GENERAL REQUIREMENTS FOR INSTRUMENTATION AND CONTROL
SECTION 17030 PROCESS INSTRUMENTATION AND CONTROL SYSTEM TESTING
SECTION 17110 INSTRUMENT AND CONTROL PANELS
SECTION 17900 CONTROL SPECIFICATIONS

101 SUBMITTAL PROCEDURES - INDEX

101 SUBMITTAL PROCEDURES

101.1 GENERAL

The Contractor shall make submittals as required by the specifications. The Engineer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor.

101.1.1 DEFINITIONS

101.1.1.1 Submittal: Shop drawings, product data, samples, operation and maintenance data presented for review and approval. Contract General Condition Paragraph 10, Workmanship and Superintendence shall apply to all submittals.

101.1.1.2 Types of Submittals: All submittals shall be grouped as follows:

101.1.1.2.1 Shop drawings: Drawings, schedules, diagrams, and other data prepared specifically for this contract, by Contractor or through Contractor by way of subcontractor, manufacturer, supplier, distributor, or other lower tier Contractor, to illustrate portion of work. Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated

101.1.1.2.2 Product data: Preprinted material such as illustrations, standard schedules, performance charts, instructions, brochures, diagrams, manufacturer's descriptive literature, catalog data, and other data including size, physical appearance and other characteristics of materials or equipment to illustrate portion of work, but not prepared exclusively for this contract. Samples of warranty language when the contract requires extended product warranties.

101.1.1.2.3 Samples: Physical examples of materials, equipment, products, assemblies or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project. Field samples and mock-ups constructed on the project site establish standards by which the ensuing work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

101.1.1.2.4 Operation and Maintenance (O&M) Data: Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance, and repair of the item. The data is to be on hand when the item is delivered to the project site.

101.1.1.2.5 Design Data: Calculations, mix designs, analyses, or other data pertaining to a part of work.

101.1.1.2.6 Test Reports: Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product, or system to be provided has been tested in accord with specified requirements. Testing shall be within three (3) years of date of contract award for the project. Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site. Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation, including investigation reports, daily checklists, final acceptance tests, and operational test procedures.

101.1.1.2.7 Certificates: Statements signed by responsible officials of manufacturer of product, system, or material attesting that product, system, or material meets specification requirements. The certificates must be dated after the award of the project contract and clearly name the project. Certificates shall be documents required of the Contractor, or of a supplier, installer, or subcontractor through the Contractor, the purpose of which is to further the quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

101.1.1.2.8 Manufacturer's Instructions: Preprinted material describing installation of a product, system, or material, including special notices and Material Safety Data sheets concerning impedances, hazards, and safety precautions.

101.1.1.2.9 Manufacturer's Field Reports: Documentation of factory test reports, testing, and verification actions taken by the manufacturer's representative to confirm compliance with the manufacturer's standards or instructions shall be provided.

101.1.1.3 Closeout Submittals: Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

101.1.1.4 Approving Authority: Contractor’s authorized person to approve submittal.

101.1.1.5 Submittal Register: At the end of this Section a list showing items of equipment and material for which submittals are required by the specifications is provided. This list may not be all inclusive and additional submittals may be required. It is the Contractor’s responsibility to maintain a complete register of all the submittals.

101.1.1.6 Work: As used in this section, on- and off-site construction required by Contract Documents including labor necessary to produce submittals, materials, products, equipment, and systems incorporated or to be incorporated.

101.2 MATERIALS

101.2.1 TRANSMITTAL FORM

Transmit each submittal, except sample installations and sample panels, to the office of the

engineer. The transmittal form shall identify the Contractor, indicate date of submittal, and include information prescribed by transmittal form and required in Paragraph 101.2.2. Process transmittal forms to record actions regarding sample panels and sample installations.

101.2.2 IDENTIFYING SUBMITTALS

Identify submittals, except sample panel and sample installation, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:

I. Project title and location
II. Construction contract number
III. Section number of the specification section by which submittal is required
IV. Submittal description of each component of submittal
V. Each submittal shall be numbered, for example, Section # - 2, for accurate tracking
VI. When a resubmission is required add alphabetic suffix on submittal number, for example, Section # - 2A to indicate resubmission
VII. Name, address and telephone number of subcontractor, supplier, manufacturer and any other second tier Contractor associated with submittal
VIII. Product identification and location in project

101.2.3 FORMAT FOR SHOP DRAWINGS

I. Shop drawings shall not be less than 8 1/2 by 11 inches nor more than 24 by 36 inches
II. Present 8 1/2 by 11 inches sized shop drawings as part of the bound volume for required submittals
III. Present larger drawings in sets
IV. Include on each drawing the drawing title, number, date, and revision numbers and dates
V. Drawing information shall be included in addition to information required in the Paragraph 101.2.2
VI. Drawings shall be to scale and dimensioned except for diagrams and schematic drawings
VII. Drawings shall be prepared to demonstrate interface with other trades
VIII. Shop drawings' dimensions shall be the same unit of measure as indicated on the contract drawings
IX. Shop drawings shall identify materials and products for work shown

101.2.4 FORMAT OF PRODUCT DATA

I. Present product data submittals for each section as a complete, bound volume
II. Volume shall include a table of contents, listing page, and catalog item numbers for product data
III. Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains
IV. Supplement product data with material prepared for the project to satisfy submittal

requirements for which product data does not exist and identify this material as developed

101.2.5 FORMAT OF SAMPLES

Furnish samples in sizes as described below, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately same size as specified below:

I. Sample of equipment or devices shall be full sized
II. Samples of materials less than 2 by 3 inches shall be built up to 8 1/2 by 11 inches
III. Sample of materials exceeding 8 1/2 by 11 inches shall be cut down to 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations
IV. Sample of linear devices or materials shall be 10 inches in length or the length to be supplied for construction if less than 10 inches
V. Examples of linear devices or materials include conduit and handrails
VI. Samples of non-solid materials, such as sand and paint, shall be submitted in the volume of a pint
VII. Color selection samples shall be 2 by 4 inches
VIII. The sample panels shall be 4 by 4 feet
IX. The sample installation shall be 100 square feet

101.2.5.1 Samples Showing Range of Variation: Where variations are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range.

101.2.5.2 Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples shall be in undamaged condition at time of use.

101.2.5.3 Recording of Sample Installation: Note and preserve the notation of area constituting sample installation but remove notation at final cleanup of project.

101.2.5.4 Other: When color, texture or pattern is specified by naming a manufacturer and style, include one (1) sample of that manufacturer and style, for comparison.

101.2.6 FORMAT OF OPERATION AND MAINTENANCE (O&M) DATA

O&M Data formats shall comply with the requirements specified by each Section indicating a O&M Data submittal requirement.

101.2.7 QUANTITY OF SUBMITTALS

101.2.7.1 Number of Copies of Shop Drawings: Submit five (5) copies of submittals and shop drawings for review and approval.

101.2.7.2 Number of Copies of Product Data: Submit product data in compliance with the quantity requirements specified for shop drawings per each Section. If quantities are not so described, submit five (5) copies of product data for review and approval.

101.2.7.3 Number of Copies of Samples:

I. Submit two (2) samples, or two (2) sets of samples, showing range of variation of each required item
II. One (1) approved sample or set of samples will be retained by the Engineer and one will be returned to the Contractor
III. Submit one sample panel and include components listed in technical section or as directed
IV. Submit one sample installation where directed
V. Submit one sample of non-solid materials

101.2.7.4 Number of Copies of Operation and Maintenance Data: Submit five (5) copies of O&M Data to the Engineer for review and approval.

101.3 EXECUTION

101.3.1 REVIEWING, CERTIFYING

The Contractor shall be responsible for reviewing and certifying that submittals are in compliance with contract requirements. Only one manufacturer per product item shall be submitted. Submission of multiple manufacturers for one product shall be grounds for disapproval.

101.3.1.1 Procedures: The Engineer will further discuss detailed submittal procedures with the Contractor at the Preconstruction Conference.

101.3.1.2 Preconstruction Submittals: The following list shall be provided prior to start of construction:

I. List of proposed products
II. Construction Progress Schedule
III. Submittal register
IV. Environmental protection plan
V. Storm Water Pollution Prevention Plan
VI. Traffic control plan(s)

101.3.2 CONSTRAINTS

I. Submittals listed or specified in this contract shall conform to provisions of this section unless explicitly stated otherwise by the Engineer
II. Submittals shall be complete for each definable feature of work; components of definable feature interrelated as a system shall be submitted at same time
III. When acceptability of a submittal is dependent on conditions, items, or materials included in separate subsequent submittals, submittal will be returned without review
IV. Approval of a separate material, product, or component does not imply approval of assembly in which item functions

101.3.3 APPROVED SUBMITTALS

The Engineer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory to the project requirements. Approval will not relieve the Contractor of the responsibility for any error which may exist. After submittals have been approved by the Engineer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

101.3.4 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Engineer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract General Condition ADDITIONAL, OMITTED OR CHANGED WORK shall be given promptly to the Engineer.

101.3.5 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made and approved prior to acquisition of material or equipment covered therein. The Contractor shall provide ample time for review and delivery of the approved material prior to installation of material or equipment.

101.4 MEASUREMENT AND PAYMENT

Measurement and payment for the work covered by this Section of the specifications shall be considered incidental to the items of work described in the Special Conditions.

102 PROGESS SCHEDULE - INDEX

102 PROGESS SCHEDULE

102.1 GENERAL

102.1.1 CONSTRUCTION PROGRESS CHART

Pursuant to the General Conditions Paragraph 18 entitled “Construction Schedule” the Contractor shall prepare a schedule of construction utilizing a construction progress chart as described herein.

102.2 MATERIALS

The Contractor shall prepare the construction progress chart with the following considerations and features:

I. The contract work shall be divided into definable contract features and as a minimum, the Contractor shall address each specification bid item as a principal contract feature

II. The weighted value (WT.) column should indicate the percentage of the contract for which each principle contract feature accounts

III. The vertical lines shall be identified by specific time frames, (i.e.,weekly, bi-weekly, monthly) with one (1) space accounting for no more than one (1) month

IV. Identify the date when Notice to Proceed is acknowledged on the chart

V. Identify the contract completion date on the chart

The Contractor shall place bars on the chart indicating scheduled progress and actual progress for each feature of work. The Contractor shall note the anticipated and actual percentage complete for each item at the end of each month and at the end of each scheduled block. Activities shall be identified by respective bid items.

The progress chart shall reflect the construction sequencing required to maintain utility service (water, sewer, gas, electric communication, etc.) to customers throughout the project.

102.3 EXECUTION

The Contractor shall submit a copy of the Construction Progress Chart for review and approval prior to issuing the Notice to Proceed. No progress payments will be made without an approved progress chart.

Contractor shall submit an updated schedule at the end of each month illustrating the actual progress verses anticipated progress.

102.4 MEASUREMENT AND PAYMENT

Measurement and payment for the work covered by this section of the Specifications shall be considered incidental to the items of work described in the Special Conditions.

105 PROTECTED SPECIES- INDEX

105 PROTECTED SPECIES

105.1 GENERAL

105.1.1 PROJECT CONDITIONS

Certain native species in the State of New Mexico are protected plant or animal species under State law(s). The Government has ascertained that endangered Migratory Birds may exist in the areas to be disturbed by construction activities.

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

105.1.1.1 Migratory Birds:

I. Between March 15th and August 15th

i. The Federal Government will retain a qualified wildlife biologist to survey any vegetated area to be disturbed for endangered migratory birds. The evaluation shall be performed no more than five (5) days before an area is to be disturbed.

ii. Notify the Contracting Officer Representative (COR) 72 hours before disturbing an area. Contact information to be made available at the Pre-Construction Meeting.

iii. Do not disturb a mating pair of endangered migratory birds with an egg.
A. Avoid the birds directed by the COR

105.2 MATERIALS

Materials are not listed in this Section.

105.3 EXECUTION

105.3.1 CONTRACTOR RESPONSIBILITES

Insert this section in subcontracts which involve performance of work in areas where protected species may occur

105.3.2 SPECIES REMOVAL

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

105.4 MEASUREMENT AND PAYMENT

Measurement and payment for the work covered by this section of the specifications shall be considered incidental to the items of work described in the Special Conditions.

106 PRESERVATION OF HISTORICAL AND ARCHAELOGICAL DATA- INDEX

106 PRESERVATION OF HISTORICAL AND ARCHAELOGICAL DATA

106.1 GENERAL

Federal legislation provides for protection, preservation, and collection of scientific, prehistoric, historical, and archaeological data, including relics and specimens, which might otherwise be lost due to alteration of terrain as a result of any Federal construction project.

Any person who, without permission, injures, destroys, excavates, appropriates, or removes any historical or pre-historical artifact, object of antiquity, or archaeological resource on public lands of the United States is subject to arrest and penalty of law.

Comply with State laws when operating on non-Federal and non-Indian lands.

106.1.1 DEFINITIONS

106.1.1.1 Cultural Resources: Includes prehistoric, historic, architectural, and traditional cultural properties. These include, but are not limited to, human skeletal remains, archaeological artifacts, records and material remains related to such property.

106.1.1.2 Cultural Items: Native American cultural items (i.e., funerary objects, sacred objects, objects of cultural patrimony, or human remains) for which protection is prescribed under the Native American Graves Protection and Repatriation Act (NAGPRA) – Public Law 101-601; Stat. 3042, Section 3(d); and 43 CFR Part 10.4.

106.1.1.3 Human Remains: Physical remains of the body of a person.

106.1.1.4 Funerary Objects: Native American items that, as part of the death rite or ceremony of a culture, are reasonably believed to have been placed intentionally at the time of death or later with or near individual human remains.

106.1.1.5 Native American: Of, or relating to, a tribe, people, or culture that is indigenous to the United States.

106.1.1.6 Sacred Objects: Native American items that are specific ceremonial objects needed by traditional Native American religious leaders for the practice of traditional Native American religions by their present-day adherents. These items are specifically limited to objects that were devoted to a traditional Native American religious ceremony or ritual and which have religious significance or function in the continued observance or renewal of such ceremony.

106.1.1.7 Objects of Cultural Patrimony: Native American items having ongoing historical, traditional, or cultural importance central to the Indian tribe itself, rather than property owned by an individual tribal member. These objects are of such central

importance that they may not be alienated, appropriated, or conveyed by any individual tribal member.

106.1.2 PROJECT CONDITIONS

The project site has been surveyed and potential archaeological sites have been identified.

I. The project crosses areas with cultural resources

i. No work shall proceed in between the stations listed for the Exclusion Zones until receipt of a written Notice to Proceed from the Contracting Officer Representative (COR) that includes them.

A. Exclusion Zones:

a. 16" Waterline Station 49 + 14 to Station 50 + 37
b. 16" Waterline Station 76 + 50 to Station 78 + 50
c. 12" Waterline Station 13 + 35 to Station 14 + 50
d. 12" Waterline Station 28 + 50 to Station 29 + 25

ii. The Government or Engineer will retain an Archaeologist to monitor the work in these areas.

A. The Contractor shall coordinate all work within these zones with Government or Engineer's Archaeologist.

106.2 MATERIALS

Materials are not used in this Section.

106.3 EXECUTION

106.3.1 DISCOVERY OF RESOURCES

When the Contractor, or any of the Contractor's employees, or parties operating or associated with the Contractor, in performance of this contract discover cultural resources on any lands:

I. Immediately cease work at that location.

II. Provide immediate verbal notification to the COR, giving the location and nature of the findings

III. Provide immediate verbal notification to the United States Bureau of Reclamation (USBR) staff archaeologist in Durango, Colorado.

IV. Follow with written confirmation to the COR within 12 hours.

In addition to notifying the COR; where the discovery occurs on state, tribal, municipal, or private lands, notify the appropriate Law Enforcement officials as prescribed by law or within two (2) days, whichever is more stringent.

Exercise care so as not to disturb or damage cultural resources uncovered during construction activities, and provide such cooperation and assistance as may be necessary to preserve the findings for removal or other disposition by the COR.

Do not resume work in the area of discovery until receipt of written notice to proceed from the COR.

Note: Contact information to be provided at the preconstruction meeting.

106.3.2 DELAYS

Where appropriate by reason of discovery, the COR may order delays in time of performance or changes in work, or both. When such delays or changes are ordered, an equitable adjustment will be made in the contract in accordance with applicable clauses of the contract.

106.3.3 ACCESS

Coordinate for Government access in arrangements for use of private lands for use areas or borrow sources. Government access to the private land shall be to identify cultural resources and conduct appropriate inspections

106.3.4 CONTRACTOR RESPONSIBILITIES

Insert this section in agreement of contracts with subcontractors which involve performance of work on jobsite terrain.

106.4 MEASUREMENT AND PAYMENT

Measurement and payment for the work covered by this Section of the specifications shall be considered incidental to the items of work described in the Special Conditions.

107 STORM WATER POLLUTION PREVENTION - INDEX

107 STORM WATER POLLUTION PREVENTION

107.1 GENERAL

107.1.1 GENERAL REQUIREMENTS

Implement the Storm Water Pollution Prevention measures to prevent sediment from entering streams or water bodies as specified in this Section. Conform with the requirements of the National Pollution Discharge Elimination System (NPDES) permit that can be found in the appendices of these Specifications.

107.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include but are not limited to the following:

I. Section 101, Submittal Procedures
II. Section 108, Water Pollution Control
III. Appendix C, EPA Forms (NPDES) Notice of Intent and Notice of Termination.
IV. Appendix D [401/404 Permits]

107.1.3 DESCRIPTION

This item of work shall consist of furnishing all material, supplies, plant and labor required for construction, installment and maintenance of temporary erosion control measures to prevent the erosion of cleared and grubbed areas and the sedimentation of rivers, streams and impoundments, and pollution of private properties from storm water. The items of work covered in this section are required for implementation of the Storm Water Pollution Prevention Plan.

Storm Water Pollution Prevention Plan is to be prepared by the Contractor for approval by the City, the Bureau of Reclamation, and the New Mexico State Highway Department.

107.1.4 SUBMITTALS

Engineer approval is required for submittals. The following shall be submitted in accordance with Section 101.

107.1.4.1 Certificates:

I. Mill Certificate or Affidavit.
II. Certificate attesting that the Contractor has met all specified requirements.

107.1.5 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described below.

107.1.5.1 Stabilization Practices: The stabilization practices to be implemented include but are not limited to vegetative buffer strips, erosion control mats, protection of trees, preservation of mature vegetation, etc. On a daily report, record the dates when the major grading activities occur, (e.g., clearing and grubbing, excavation, embankment, and grading); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in Paragraphs 107.1.5.1.1 and 107.1.5.1.2, stabilization practices must be initiated as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have temporarily or permanently ceased.

107.1.5.1.1 Unsuitable Conditions: Where the initiation of stabilization measures by the fourteenth day after construction activity temporarily or permanently ceases or is precluded by unsuitable conditions caused by the weather, stabilization practices shall be initiated as soon as practicable after conditions become suitable.

107.1.5.1.2 No Activity for Less Than 21 Days: When the total time period in which construction activity is temporarily ceased on a portion of the site is 21days minimum, stabilization practices do not have to be initiated on that portion of the site until 14 days have elapsed after construction activity temporarily ceased.

107.1.5.2 Structural Practices: Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Structural practices shall include the following devices.

107.1.5.2.1 Silt Fences: The Contractor shall provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Silt fences shall be properly installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Silt fences shall be installed in the locations indicated on the drawings. Final removal of silt fence barriers shall be upon approval by the Engineer.

107.1.5.2.2 Straw Bales: Provide bales of straw as a temporary structural practice to minimize erosion and sediment runoff. If bales are used, properly place the bales to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in an area between a ridge and drain, place the bales as work progresses, remove/replace/relocate the bales as needed for work to progress in the drainage area). Show on the drawings areas where straw bales

are to be used. The Engineer will approve the final removal of straw bale barriers. Rows of bales of straw shall be provided as follows:

I. Along the downhill perimeter edge of all areas disturbed
II. Along the top of the slope or top bank of drainage ditches, channel, swales, etc. that traverse disturbed areas
III. Along the toe of all cut slopes and fill slopes of the construction areas
IV. Perpendicular to the flow in the bottom of existing drainage ditches, channels, swales, etc. that traverse disturbed areas or carry runoff from disturbed areas
V. Space the rows a maximum of two (2) feet apart
VI. Perpendicular to the flow in the bottom of new drainage ditches, channels, and swales. Space the rows a maximum of two (2) feet apart
VII. At the entrance to culverts that receive runoff from disturbed areas

107.1.5.2.3 Diversion Dikes: Build diversion dikes with a maximum channel slope of 2 percent and adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches. The minimum base width shall be 6 feet and the minimum top width shall be two (2) feet. Ensure that the diversion dikes are not damaged by construction operations or traffic. Locate diversion dikes where shown on the drawings.

107.2 MATERIALS

107.2.1 COMPONENTS FOR SILT FENCES

107.2.1.1 Filter Fabric: The geotextile must comply with the requirements of ASTM D 4439 and consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six (6) months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the requirements in Table 1 and Table 2.

TABLE 1: FILTER FABRIC FOR SILT SCREEN FENCE (METRIC)

PHYSICAL PROPERTY REQUIREMENT	TEST PROCEDURE	STRENGTH
Grab Tensile	ASTM D 4632	445 N min.
Elongation (%)		30% max.
Trapezoid Tear	ASTM D 4533	245 N min.
Permittivity	ASTM D 4491	0.2 sec-1
V.AOS (U.S. Std. Sieve)	ASTM D 4751	20-100

TABLE 2: FILTER FABRIC FOR SILT SCREEN FENCE (IMPERIAL)

PHYSICAL PROPERTY REQUIREMENT	TEST PROCEDURE	STRENGTH
Grab Tensile	ASTM D 4632	100 lbs. min.
Elongation (%)		30% max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.
Permittivity	ASTM D 4491	0.2 sec-1
V.AOS (U.S. Std. Sieve)	ASTM D 4751	20-100

107.2.1.2 Silt Fence Stakes and Posts: Use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction shall have a minimum cross section of 2 by 2 inches when oak is used and 4 by 4 inches when pine is used. The minimum length shall be a minimum length of five (5) feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction shall have a minimum mass of 1.33 pounds/linear foot and a minimum length of five (5) feet.

107.2.1.3 Mill Certificate or Affidavit: A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers. The Contractor shall submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric.

107.2.1.4 Identification Storage and Handling: Filter fabric shall be identified, stored, and handled in accordance with ASTM D 4873.

107.2.2 COMPONENTS FOR STRAW BALES

The straw in the bales shall be stalks from oats, wheat, rye, barley, rice, or from grasses such as byhalia, bermuda, etc., furnished in air dry conditions. The bales shall have a standard cross section of 14 by 18 inches. All bales shall be either wire-bound or string-tied. The Contractor may use either wooden stakes or steel posts to secure the straw bales to the ground. Wooden stakes utilized for this purpose shall have a minimum dimension of 2 by 2 inches in cross section and shall have a minimum length of three (3) feet. Steel posts (standard "U" or "T" section) utilized for securing straw bales shall have a minimum mass of 1.33 pounds/linear foot and a minimum length of three (3) feet.

107.3 EXECUTION

107.3.1 INSTALLATION

107.3.1.1 Silt Fences: Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Filter fabric shall form a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are

unavoidable, filter fabric shall be spliced together at a support post, with a minimum 6-inch overlap, and securely sealed. A trench shall be excavated approximately four (4) inches wide and four (4) inches deep on the upslope side of the location of the silt fence. The 4 by 4-inch trench shall be backfilled and the soil compacted over the filter fabric. Silt fences shall be removed upon approval by the Engineer.

107.3.1.2 Straw Bales: Place the straw bales in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of four (4) inches. After the bales are staked and chinked (gaps filled by wedging with straw), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to four (4) inches against the uphill side of the barrier. Loose straw shall be scattered over the area immediately uphill from a straw bale barrier to increase barrier efficiency. Each bale shall be securely anchored by at least two (2) stakes driven through the bale. The first stake or steel post in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or steel pickets shall be driven a minimum 18 inches deep into the ground to securely anchor the bales.

107.3.2 MAINTENANCE

The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. Use the following procedures to maintain the protective measures.

107.3.2.1 Silt Fence Maintenance: Silt fences shall be inspected in accordance with Paragraph 107.3.4. Any required repairs shall be made promptly. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach 1/3 of the height of the barrier. When a silt fence is no longer required, it shall be removed upon the approval of the Engineer. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded.

107.3.2.2 Straw Bale Maintenance: Straw bale barriers shall be inspected in accordance with Paragraph 107.3.4. Close attention shall be paid to the repair of damaged bales, end runs and undercutting beneath bales. Necessary repairs to barriers or replacement of bales shall be accomplished promptly. Sediment deposits shall be removed when deposits reach 1/2 of the height of the barrier. Bale rows used to retain sediment shall be turned uphill at each end of each row. When a straw bale barrier is no longer required it shall be removed unless otherwise specified by the Engineer. The immediate area occupied by the bales

and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded.

107.3.2.3 Diversion Dike Maintenance: Diversion dikes shall be inspected in accordance with Paragraph 107.3.4. Close attention shall be paid to the repair of damaged diversion dikes and necessary repairs shall be accomplished promptly. When diversion dikes are no longer required, they shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded.

107.3.3 RESEEDING

Reseeding to be accomplished only in areas shown on the drawings or as directed. Areas cleared and grubbed for construction activity shall be returned to their original grade and contour to the extent possible. These areas shall be reseeded within two (2) weeks of final construction.

107.3.3.1 Seed Mixture: Use the following pure live seed mixture per acre for certified seed, where PLS (Pure Live Seed) = Germination times Purity. Planting Rate of 16.5 PLS/Acre. No primary or secondary noxious weeks shall be present in seed mixture. The local seed mixture shall be as described in Table 3.

TABLE 3: SEED MIXTURE REQUIREMENTS

Pure Live Seed	Application PLS# / ACRE
Fourwing Saltbush	1.00
Alkali Sacaton	1.00
Indian Rice Grass, Paloma	5.00
Galleta, Viva	2.00
Sideoats Grama, El Reno	3.00
Western Wheatgrass, Arriba	4.00
Shadescale Saltbush	0.50

107.3.3.2 Application: Compacted areas shall be ripped or scarified to a depth of twelve inches and disked to a depth of six (6) inches before seeding. Seed with a disk type drill with two boxes for various seed sizes. The drill rows shall be eight (8) to ten (10) inches apart. The seed shall be planted at not less than 1/2 inch deep or more than one (1) inch deep. The seeder shall be followed with a drag, packer or roller to ensure uniform coverage of the seed and adequate compaction. Drilling shall be done on the contour where possible, not up and down the slope.

Water for dust control shall be provided during the seeding process. Seeding shall be accomplished and 100% complete two (2) weeks after project completion.

Labels from each seed bag shall be available for inspection.

107.3.4 INSPECTIONS

107.3.4.1 General: The Contractor shall inspect disturbed areas of the construction site at least once every month. Areas that have not been finally stabilized, used for storage of materials, exposed to precipitation, covered with stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Where sites have been finally stabilized, such inspection shall be conducted at least once every month.

107.3.4.2 Inspections Details: Disturbed areas and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan shall be observed to ensure that they are operating correctly. Discharge locations or points shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

107.3.4.3 Inspection Reports: For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Storm Water Pollution Prevention Plan, maintenance performed, and actions taken. The report shall be furnished to the Engineer within 24 hours of the inspection as a part of the Contractor's daily activities. A copy of the inspection report shall be maintained on the job site.

107.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the specification shall be incidental to the project costs.

108 WATER POLLUTION CONTROL - INDEX

108 WATER POLLUTION CONTROL

108.1 GENERAL

108.1.1 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 107, Storm Water Pollution Prevention
III. Appendix C, EPA Forms (NPDES) Notice of Intent and Notice of Termination
IV. Appendix D [401/404 Permits]

108.1.2 SUBMITTALS

108.1.2.1 Submittal Procedures: Submit the following in accordance with Section 101.

108.1.2.2 Updated Stormwater Pollution Prevention Plan: As required by the stormwater permit for discharges from construction sites. Include copy of permits.

108.1.2.3 Spill Prevention, Control, and Countermeasure (SPCC) Plan:

I. Submit when SPCC Plan is required in accordance with 40 CFR, Part 112.
   i. SPCC Plan is required where release of oil and oil products could reasonably expected to enter into or upon navigable waters of the United States or adjoining shorelines in quantities that may be harmful (40 CFR, Part 110), and aggregate on site oil storage capacity is over 1,320 gallons. Only containers with capacity of 55 gallons and greater are included in determining on site aggregate storage capacity.

II. Reviewed and certified by a registered professional Engineer in accordance with 40 CFR, Part 112, as required by Section 311 of the Clean Water Act (Public Law 92-500 as amended)

III. Submit a spill prevention plan for oil storage less than 1,320 gallons. The spill prevention plan shall be certified by a professional Engineer and include:
   i. Oil storage quantity.
   ii. Drawings of containment.
   iii. Response plan to spill.

108.1.3 REGULATORY REQUIREMENTS

108.1.3.1 Construction Safety Standards: All Federal, State, and local requirements apply.

108.1.3.2 Laws, Regulations, and Permits: Perform construction operations to comply, and ensure subcontractors comply with:

I. Applicable Federal, State, Navajo Nation and local laws, orders, regulations, and Water Quality Standards concerning control and abatement of water pollution; and terms and conditions of applicable permits issued by permit issuing authority.

II. If conflict occurs between Federal, State, Navajo Nation and local laws, regulations, and requirements, the most stringent shall apply.

108.1.3.3 Contractor Violations:

I. If noncompliance should occur, immediately (verbally) report noncompliance to the City. Submit specific written information within 2 days.

II. Violation of applicable Federal, State, or local laws, orders, regulations, or Water Quality Standards may result in the City stopping site activity until compliance is ensured.

III. The Contractor shall not be entitled to extension of time, claim for damage, or additional compensation by reason of such a work stoppage.

IV. Corrective measures required to bring activities into compliance shall be at the Contractor's expense.

108.1.4 REQUIRED PERMITS

108.1.4.1 Wastewater Discharge Permit:

108.1.4.1.1 Permit:

I. Prior to discharging wastewater or other pollutants, Contractor shall secure permit(s) to discharge pollutants as required under Section 402 of the Clean Water Act (Public Law 92-500 as amended), and/or The New Mexico Environment Department, Surface Water Quality Bureau and/or the Navajo Nation Environment Protection Agency.

II. Submit application(s) to the City, and to USBR for review before submitting to the agencies.

108.1.4.1.2 Terms and Conditions:

I. Comply with terms and conditions as stated in the permit.

108.1.4.1.3 Monitoring and Treatment:

I. Provide monitoring and water treatment, if necessary, to achieve compliance with permit conditions.
II. Provide recordkeeping required of the permittee, as stated in the permits.

108.1.4.1.4 Sampling:

I. Include sampling in monitoring required of the Contractor to meet section requirements, as well as required laboratory tests to determine effluent characteristics.

108.1.4.1.5 Monitoring Results:

I. Provide monitoring results to the appropriate agency as required by the permit.

II. Send copies of all information transmitted to the appropriate agency and to the City.

108.1.4.2 Dredge and Fill Permit: The Bureau of Reclamation has submitted or will submit an application to the United States Army Corps of Engineers for a Nationwide Permit to discharge dredged or fill material into waters of the United States (including wetlands) as required under Section 404 of the Clean Water Act (Public Law 92-500 as amended).

The Bureau of Reclamation is the Section 404 dredge and fill permit holder (permittee), Reclamation will make known the conditions of permit to the Contractor and then may transfer the permit to the Contractor. The granted Nationwide Permits are contained in the appendices of these Specifications.

108.1.4.3 Stormwater Discharge Permit Associated with a Construction Site:
The Contractor shall obtain a stormwater general permit to control stormwater discharges from the construction site as required under Section 402 of the Clean Water Act (Public Law 92-500, as amended)

108.1.4.3.1 Pollution Prevention Plan:

I. The Contractor shall prepare a Pollution Prevention Plan as required by the permit.

II. Comply with terms and conditions to obtain and maintain the stormwater discharge permit.

108.1.4.3.2 Monitoring and Water Treatment:

I. Provide monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards.

II. Provide the recordkeeping required by the stormwater discharge permit associated with construction activity.

108.1.4.4 Stormwater Discharge Permit Associated with Industrial Activity:

108.1.4.4.1 Stormwater Discharge Permit:

I. If construction activities will entail the use of a mobile plant, or nonmetallic borrow areas, a stormwater discharge permit associated with industrial activity may be required.

108.1.4.4.2 Notice of Intent (NOI):

I. Sign the NOI to obtain coverage under a stormwater general permit to control stormwater discharges from industrial activity at the construction site as required under section 402 of the Clean Water Act (Public Law 92-500, as amended) and/or The New Mexico Environmental Department, Surface Water Quality Bureau and/or the Navajo Nation Environmental Protection Agency.

108.1.4.4.3 Term and Conditions:

I. Comply with terms and conditions to obtain and maintain the industrial stormwater discharge permit, including the preparation of a Pollution Prevention Plan.

108.1.4.4.4 Monitoring and Water Treatment:

I. Provide monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards.

II. Provide monitoring results to the appropriate agency as required by the permit.

III. Send copies of all information transmitted to the appropriate agency and to the City.

108.1.5 CONTRACTOR RESPONSIBILITIES

108.1.5.1 Permits: Contractor is responsible for all permits.

108.1.5.2 Monitoring: Conduct monitoring in order to meet the requirements of the permits which may include:

I. Sampling,
II. Site inspections, and
III. Required laboratory tests to determine effluent characteristics.

108.1.5.3 Reporting Results: Provide monitoring results to the appropriate agency as required by the permit. Send copies of all information transmitted to the appropriate agency to the City.

108.1.5.4 Recordkeeping: Retain records and data for the life of the project or as required by permits, whichever is longer.

108.1.6 REFERENCE STANDARDS

108.1.6.1 Bureau of Reclamation (USBR): RSHS-2009 Reclamation Safety and Health Standards.

108.1.6.2 Code of Federal Regulations (CFR): 40 CFR, Part 112 Oil Pollution Prevention.

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

108.2 MATERIALS

Materials are not listed in this section.

108.3 EXECUTION

108.3.1 POLLUTION CONTROLS

108.3.1.1 On Site Controls: Control pollutants by use of sediment and erosion controls, wastewater and stormwater management controls, construction site management practices, and other controls including State and local control requirements.

108.3.1.2 Sediment and Erosion Controls:

I. Establish methods for controlling sediment and erosion which address vegetative practices, structural control, slit fences, straw dikes, sediment controls, and operator controls as appropriate.

II. Institute stormwater management measures as required, including velocity dissipaters, and solid waste controls which address controls for building materials and offsite tracking of sediment.

108.3.1.3 Wastewater and Stormwater Management Controls:

108.3.1.3.1 Pollution Prevention Measures:

I. Use methods of dewatering, unwatering, excavating, or stockpiling earth and rock materials which include prevention measures to control silting and erosion, and which will intercept and settle any runoff of sediment-ladened waters.

II. Prevent wastewater from general construction activities such as drain water collection, aggregate processing, concrete batching, drilling, grouting, or other construction operations, from entering flowing or dry watercourses without the use of approved turbidity control methods.

III. Divert stormwater runoff from upslope areas away from disturbed areas.

108.3.1.3.2 Turbidity Prevention Measures:

I. Use methods for prevention of excess turbidity which include, but are not restricted to, intercepting ditches, settling ponds, gravel filter entrapment dikes, flocculating processes, recirculation, combinations thereof, or other approved methods that are not harmful to aquatic life.

II. Wastewaters discharged into surface waters shall meet conditions of the permit(s).

III. Do not operate mechanized equipment in water bodies without having first obtained a Section 404 permit, and then only as necessary to construct crossings or perform the required construction.

108.3.1.4 Construction Site Management:

108.3.1.4.1 Contractor Construction Operations:

I. Perform construction activities by method that will prevent entrance, or accidental spillage, of solid matter, containments, debris, or other pollutants or wastes into stream, flowing or dry watercourses, lakes, wetlands, reservoirs, or underground water sources.
   i. Pollutants and wastes include, but are not restricted to: refuse, garbage, cement, sanitary waste, industrial waste, hazardous materials, radioactive substances, oil and other petroleum products, aggregate processing tailings, mineral salts, and thermal pollution.

108.3.1.4.2 Stockpiled or Deposited Materials:

I. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff, or can in any way encroach upon the watercourse.

108.3.1.4.3 Petroleum Product Storage Tanks Management:

I. Place oil or other petroleum product storage tanks at least 50 feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and any other water source.

II. Do not use underground storage tanks.

III. Construct storage area dikes at least 12 inches high or graded and sloped to permit safe containment of leaks and spills equal to storage tank capacity located in the area plus sufficient freeboard to contain the 25-year rainstorm.

i. Line diked areas with an impermeable barrier at least 50 mils thick.

IV. Area for refueling operations: Lined with impermeable barrier at least 10 mils thick covered with two (2) to four (4) inches of soil.

108.4 MEASUREMENT & PAYMENT

Measurement and payment for items of work covered by this section of the specification shall be incidental to the project costs.

201 GENERAL EARTHWORK – INDEX

201 GENERAL EARTHWORK

201.1 GENERAL

201.1.1 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 107, Storm Water Pollution Prevention
III. Section 203, Trenching, Excavation, and Backfilling
IV. Section 204, Fill Materials

201.1.2 DESCRIPTIONS

201.1.2.1 Laws and Regulatory Requirements: All excavation, trenching, bracing, etc., shall comply with the requirements of OSHA Excavation Safety Standards (29 CFR Part 1926.650 Subpart P) and any state and local requirements. Where conflict between OSHA, state or local regulations exist, the most stringent requirements shall apply.

201.1.3 DEFINITIONS

201.1.3.1 Satisfactory Materials: Satisfactory materials comprise of any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, SW, SP, SM, SW-SM. Satisfactory materials for grading shall comprise of stones less than eight (8) inches, except for fill material for pavements and railroads which comprise of stones less than three (3) inches in any dimension.

201.1.3.2 Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Engineer when encountering any contaminated materials.

201.1.3.3 Cohesionless and Cohesive Materials: Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

201.1.3.4 Degree of Compaction: Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the

test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4-inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224.

201.1.3.5 Hard/Unyielding Materials: Hard/Unyielding materials comprise of weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than six (6) inches in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

201.1.3.6 Rock: Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also, large boulders, buried masonry, or concrete other than pavement exceeding one (1) cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling that is performed merely to increase production. All stone or boulders less than eight (8) cubic feet in volume will be classified as earth.

Rock shall be broken into two (2) types as further defined below:

Type “A” Rock - extremely hard rock that is defined as rock which cannot be excavated by means other than those listed:

I. Drilling and blasting
II. Drilling and splitting with expandable chemical compound.
III. Jack hammering.
IV. Adjacent excavation and removal with large earth/rock moving equipment.

Type “B” rock - not at difficult to excavate as Type “A” rock. Type “B” rock can be excavated by any methods stated above or by large backhoes with rock teeth and experienced operators.

Rock that is hard, but ledgy or fractured and can be excavated with large backhoes, will be considered Type “B” rock. Rock that is intermittently layered with shale and that is readily excavated with backhoes will not be considered rock. Hard shale will not be considered as rock excavation. Samples of Type “A” and Type “B” rocks are available at the office of the Engineer for inspection by bidders or project Contractors.

201.1.3.7 Unstable Material: Unstable materials do not properly support the building, utility pipe, conduit, or appurtenant structure due to oversaturation.

201.1.3.8 Granular Material: Granular fill material shall be unfrozen gravel, sandy gravel or gravelly sand free of organic material, loam, trash, snow, ice or other objectionable material and shall be as specified in Section 204.

201.1.3.9 Backfill and/or Final Backfill Material: Final backfill consists of granular material or satisfactory materials (imported or native) free from rocks 3/4 inch or larger in any dimension or free from rocks of such size as required for final surfacing, whichever is smaller.

201.1.3.10 Expansive Soils: Expansive soils are defined as soils that have a plasticity index equal to or greater than 20 when tested in accordance with ASTM D 4318.

201.1.4 CLASSIFICATION OF EXCAVATION

201.1.4.1 Common Excavation: The Contractor shall perform excavation of every type of material encountered within the limits of the project to the lines, grades and elevation shown. Grading shall be in conformity with the typical cross sections shown on project drawings. Satisfactory excavated materials shall be stockpiled for use as backfill within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated and disposed of as stated in “Disposal of Surplus Material”. Surplus satisfactory excavated material shall also be disposed of as stated in “Disposal of Surplus Material”. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times.

201.1.4.2 Rock Excavation: Rock excavation includes excavating, grading, and disposing of material defined as rock. If at any time during excavation, the Contractor encounters material that may be defined as rock, uncover such material and notify the Engineer. The Contractor shall not proceed with the excavation of this material until the Engineer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Engineer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Engineer for the areas of work in which such deposits occur.

Rock excavation shall be broken into two categories according to the type of rock being excavated as defined in Paragraph 201.1.3.6 of this Section.

201.1.5 SUBMITTALS

201.1.5.1 Submittal Procedures: All submittal procedures shall be per Section 101 of the Specifications.

201.1.5.1.1 Product Data: Imported material, gradation, unit weight, proctor and PI sample results shall be approved before utilizing the following:

I. Imported Material
II. Utilization of Excavated Materials
III. Excavated Rock Materials (modified or unmodified)
IV. Borrow Pit Materials

201.1.5.1.2 Procedure and Location: Procedure and location for the following:

I. Disposal of unused satisfactory material
II. Proposed source of borrow material

201.1.5.1.3 Notification: Notification of encountering rock in the project and the advanced notice on the opening of excavation and borrow areas.

201.2 MATERIALS

201.2.1 BACKFILL

Backfill materials shall be as defined in Paragraph 201.1.3.9 or as specified in Section 204.

201.2.2 TIMBER

Timber used for excavation support system shall be pressure treated.

201.2.3 BURIED WARNING AND IDENTIFICATION TAPE FOR ENCOUNTERED UTILITY LINES

Replace disturbed polyethylene plastic warning tape manufactured specifically for warning and identification of existing buried utility lines. Replace disturbed tape with rolls, three (3) inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes:

I. Red: Electric
II. Blue: Water Systems
III. Green: Sewer Systems

201.2.3.1 Warning Tape for Metallic and Non-Metallic Piping: Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch and a minimum strength of 1500 pounds per square inch (psi) lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

201.2.3.2 Detection Wire for Metallic and Non-Metallic Piping: Insulated single strand, solid copper detection wire with a minimum of 12AWG.

201.3 EXECUTION

201.3.1 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified in the project documents. Perform the grading in accordance with the typical sections shown and the tolerances specified in Paragraph 201.3.4. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times.

201.3.1.1 Test Pits: In addition to the removal and demolition shown on the drawings, the Contractor shall perform exploratory excavation work, Test Pits, as required in order to verify the location of existing underground utilities and structures prior to excavation activities. Test pits shall be backfilled as soon as the location of the utilities has been determined. Backfilled locations shall be such that erosion of the area is minimized.

201.3.1.2 Dewatering, Drainage, and Drainage Systems: Temporary dewatering and drainage systems shall be in place prior to beginning excavation. Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry

soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions and to employ necessary measures to permit construction to proceed.

201.3.1.3 Excavation Support: The Contractor shall furnish, put in place, and maintain a braced or tied back cofferdam to support the sides of the excavation to prevent movement which could in anyway diminish the width of the excavation below that necessary for proper construction.

201.3.1.3.1 Bracing and Sheeting: In congested areas where narrowness or right-of-way, traffic, other installed utilities line, buildings or structures prevent sloping of banks, the Contractor shall be responsible to install sheet piling or operate a "boat" or caisson to maintain side slope and to protect existing improvements and work personnel. The Contractor will not be compensated for replacement of any improvements damaged due to his failure to provide proper bracing, sheeting or other restraining devices.

201.3.1.4 Drainage Structure Excavation Requirements: Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

201.3.1.5 Existing Underground Utilities: The Contractor is responsible for movement of construction machinery and equipment over existing pipes and utilities during construction. Perform work adjacent to non-City utilities as indicated in accordance with procedures outlined by utility company. Excavation made with power-driven equipment is not permitted within two (2) feet of known City-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Engineer. Report damage to utility lines or subsurface construction immediately to the Engineer.

201.3.1.6 Structural Excavation: Ensure that footing subgrades have been inspected and approved by the Engineer prior to gabion basket, revetment mattress or concrete placement.

201.3.1.7 Opening & Drainage of Excavation and Borrow Pits: The Contractor is responsible for notifying the Engineer sufficiently in advance of the opening of any excavation to permit elevations and measurements of the undisturbed ground surface to be taken. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Ensure that excavation of any area or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

201.3.2 BACKFILLING AND COMPACTION

Backfilling operations shall commence after concrete has cured for approximately 72 hours. Materials for backfill shall conform to those described in Section 204, as specified in this Section, or as called for in project documents.

Backfill shall be brought up evenly in maximum eight (8) inch lifts. Each layer of backfill material shall be thoroughly compacted by rolling, tamping or vibrating with mechanical compacting equipment or hand tamping. Compaction, shall be as called for as a percentage of standard or modified proctor. If rolling is used, it shall be by use of a suitable roller or tractor and insuring compaction throughout the backfilling area.

When the construction is within the New Mexico Department of Transportation right-of-way, the construction practices and compaction densities required in backfill shall comply with the requirements of the New Mexico Highway Commission's "Standard Specifications for Road Bridge Construction" and shall be subject to inspection by personnel of the New Mexico State Highway Department.

201.3.2.1 Utilization of Backfill Materials: Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Clear and grub designated waste areas before disposal of waste material thereon. Unsatisfactory materials removed during excavation shall be disposed into designated waste disposal or spoil areas.

201.3.2.2 Ground Surface Preparation:

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Engineer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of eight (8) inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than one (1) vertical to four (4) horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of eight (8) inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

201.3.2.3 Backfill for Appurtenances: After the manhole, catch basin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for three (3) days, place backfill in such a manner that the structure is not to be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

201.3.3 SUBGRADE PREPARATION

201.3.3.1 Proof Rolling: Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. Proof roll the existing subgrade with a 15 ton, pneumatic-tired roller. Operate the roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 2 1/2 to 3 1/2 miles per hour (mph). Notify the Engineer a minimum of three (3) days prior to proof rolling. Perform proof rolling in the presence of the Engineer. Undercut rutting or pumping of material as directed by the Engineer and replace with select material.

201.3.3.2 Construction: Shape subgrade to line, grade, and cross section, and compact as called for in project documents. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inches below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. Do not vary the elevation of the finish subgrade more than 0.05 feet from the established grades and cross sections.

201.3.3.3 Compaction: Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas.

201.3.3.3.1 Subgrade for Pavements: Compact subgrade for pavements to at least 96 percent laboratory maximum theoretical density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top six (6) inches of subgrade.

201.3.4 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown in project documents. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in Paragraph 201.3.3. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

201.3.4.1 Subgrade: During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy or frozen subgrade.

201.3.4.2 Grading Around Structures: Construct areas within five (5) feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

201.3.5 TESTING

Testing shall be the responsibility of the Contractor and shall be performed as directed by the Engineer. Perform testing by a certified commercial testing laboratory. Determine field in-place density in accordance with ASTM D 2922. When test results indicate, as determined by the Engineer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

201.3.5.1 Fill and Backfill Material Gradation: One test per each different material encountered or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C 136.

201.3.5.2 In-Place Densities:

I. One test per 200 linear feet of trench, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

II. One test per 100 linear feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

201.3.5.3 Moisture Contents: In the stockpile or excavation areas, perform a minimum of two (2) tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Engineer. It is considered acceptable to test for moisture within compacted material. If moisture content is not considered acceptable, compacted material will be removed in its entirety and reprocessed prior to retesting.

201.3.5.4 Optimum Moisture and Laboratory Maximum Density: Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

201.3.5.5 Tolerance Tests for Subgrades: Perform continuous checks on the degree of finish specified in Paragraph 201.3.3 during construction of the subgrades.

201.3.5.6 Displacement of Sewers: After other required tests have been performed and the trench backfill compacted to the finished grade surface, inspect the pipe to determine whether significant displacement has occurred. Conduct this inspection in the presence of the Engineer. Inspect pipe sizes larger than 36 inches, while inspecting smaller diameter pipe by shining a light or laser between manholes or manhole locations, or by using television cameras passed through the pipe. If, in the judgment of the Engineer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost.

201.3.6 DISPOSITION OF SURPLUS MATERIAL

Dispose of surplus material or other soil material not required or suitable for filling or backfilling, including brush, refuse, stumps and roots in accordance with all local, state and federal requirements.

Excavated material may be stockpiled without excessive surcharge on the trench bank. Contractor may temporarily stockpile in an area within the limits of construction that do not disrupt construction activities, create any nuisance or safety hazards or otherwise restrict access to the work site.

201.3.7 EXISTING UTILITIES

The Contractor shall, at his own expense, repair all damages to street, sidewalks, curbs, gutters, paving, utility lines and any other private or public properties caused by general

earthwork or other construction activities. This includes damages caused by backfill settlement within a period of one (1) year after final acceptance of the project by the Owner.

201.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the specifications shall be in accordance with provisions of the Special Conditions.

202 CLEARING AND GRUBBING – INDEX

202 CLEARING AND GRUBBING

202.1 GENERAL

202.1.1 DESCRIPTION OF WORK

This work shall consist of clearing, grubbing, removing and disposing of vegetation and debris, trash and rubble in accordance with the contract requirements and in compliance with these specifications. This work shall also include the preservation from damage or defacement of all vegetation and items designated to remain.

The Contractor shall establish right-of-way lines, property lines and construction lines based on project drawings and coordination with project Engineer. The Contractor shall preserve all trees, shrubs, plants, and other items designated to remain.

Within the construction limits, all surface debris, trees, stumps, roots, and other objectionable protruding obstructions shall be cleared and grubbed as required. The Contractor may leave undisturbed stumps and other solid objects provided they are outside the construction limits and do not interfere with construction activities.

Between the right-of-way lines and construction limits, hazardous objects and unsightly debris shall be removed. Stump holes and other holes within this area shall be backfilled with suitable material. Vegetation outside of designated demolition limits to remain.

202.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 105, Protected Species (If applicable)
III. Section 106, Preservation of Historical and Archaeological Data
IV. Section 107, Storm Water Pollution Prevention

202.1.3 SUBMITTALS

The Engineer approval is required for submittals. The following shall be submitted in accordance with Section 101:

202.1.3.1 Product Data: Non-salvageable materials. Written permission to dispose of such products on private property shall be filed with the Engineer.

202.1.3.2 Samples:

I. Tree wound paint
II. Herbicide

Submit samples in cans with manufacturer's label.

202.1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle materials in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

202.2 MATERIALS

202.2.1 TREE WOUND PAINT

Bituminous based paint of standard manufacture specially formulated for tree wounds.

202.2.2 HERBICIDE

Comply with Federal Insecticide, Fungicide, and Rodenticide Act (Title 7 U.S.C. Section 136) for requirements on Contractor's licensing, certification, and record keeping.

202.3 EXECUTION

202.3.1 PROTECTION

202.3.1.1 Roads and Walks: Keep roads and walks free of dirt and debris at all times.

202.3.1.2 Trees, Shrubs, & Existing Facilities: Trees and vegetation to be left standing shall be protected from damage due to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

202.3.1.3 Utility Lines: Protect existing utility lines from damage. Notify the Engineer immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Engineer in ample time to minimize interruption of the service.

202.3.2 CLEARING

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation designated or directed to be left in place. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1 1/2 inches or more in diameter to the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1 1/2 inches in diameter shall be painted with an approved tree-wound paint.

Apply herbicide in accordance with the manufacturer's label to the top surface of stumps designated not to be removed.

202.3.3 TREE REMOVAL

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in Paragraph 202.3.4. Trees shall be disposed of as specified in Paragraph 202.3.5.

202.3.4 GRUBBING

Grubbing shall consist of the removal and disposal of stumps, roots larger than three (3) inches in diameter, and matted roots from the designated grubbing areas. Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

202.3.5 REMOVAL AND DISPOSAL OF MATERIAL

202.3.5.1 Non-Salvageable Materials: Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations shall be disposed of in an environmentally acceptable manner. The Contractor shall be responsible for compliance with all Federal and State laws and regulations and with reasonable practice relative to disposal of unusable debris.

202.3.5.2 Alternate Disposal Methods: Materials removed from the limits of the right-of-way maybe disposed of on designated offsite private property. Contractor shall arrange for and obtain written permission from the property owner on whose property material is to be disposed of. Burning of material is strictly prohibited.

202.3.5.3 Site Conditions: The project right-of-way and adjacent areas shall be left neat and appear to be finished. Accumulation of debris on adjacent property will not be allowed, unless approved, in writing, by the property owner.

202.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the Specifications shall be in accordance with provisions of the Special Conditions.

203 TRENCHING, EXCAVATION, AND BACKFILLING – INDEX

203 TRENCHING, EXCAVATION, AND BACKFILLING

203.1 GENERAL

203.1.1 DESCRIPTION

This item of work shall consist of trenching, excavation, backfilling, restoration of site, and miscellaneous operations pertaining to installation of pipelines, facilities, structures, and appurtenances complete in strict accordance with provisions of this section of the specifications and applicable drawings. Workmanship and materials for required earthwork shall conform to the NMDOT Standard Specifications for Highway and Bridge Construction, 2014 Edition provided however, that the specifications, measurement and payment methods contained therein, or the Special Conditions shall apply.

203.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 201, General Earthwork
III. Section 204, Fill Materials
IV. Section 507, Jacking and Boring

203.1.3 DEFINITIONS

All definitions of materials and types of products shall be as defined in Section 201.

203.1.4 SUBMITTALS

203.1.4.1 Submittal Procedures: Engineer approval is required for submittals. The following shall be submitted in accordance with Section 101 of the Specifications.

203.1.4.1.1 Test Reports:

I. Field Density Tests
II. Testing of Backfill Materials

Copies of all laboratory and field test reports within seven (7) days of the completion of the test.

203.2 MATERIALS

203.2.1 SATISFACTORY MATERIALS

Satisfactory materials shall be as defined in Section 201.

203.2.2 UNSATISFACTORY MATERIALS

Unsatisfactory Materials shall be as defined in Section 201.

203.2.3 COHESIONLESS AND COHESIVE MATERIALS

Cohesion-less and Cohesive Materials shall be as defined in Section 201.

203.2.4 ROCK

Rock is defined in Section 201. Rock also consists of boulders measuring 1/2 cubic yard or more, materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, un-stratified masses, conglomerate deposits, and below ground concrete or masonry structures, exceeding 1/2 cubic yard in volume, except that pavement shall not be considered as rock.

203.2.5 UNYIELDING MATERIAL

Unyielding material shall consist of rock and gravelly soils with stones greater than 12 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

203.2.6 UNSTABLE MATERIAL

Unstable Material shall be as defined in Section 201.

203.2.7 GRANULAR MATERIAL

Granular Material shall be as defined in Section 201.

203.2.8 BEDDING OR INITIAL BACKFILL MATERIAL

Bedding or initial backfill shall consist of granular material free from rocks 3/4 inch or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 3/8 inch in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

203.3 EXECUTION

203.3.1 EXCAVATION

Excavation shall be performed in accordance with Section 201. Rock excavation shall include removal and disposition of material defined as rock in Section 201. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to half (1/2) the depth of the excavation but in no instance closer than two (2) feet.

203.3.1.1 Trench Excavation Requirements: Excavate the trench as recommended by the manufacturer of the pipe to be installed. Shore trench walls more than four (4) feet high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave-in. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide special installation procedures. The Contractor is responsible for the cost of the special installation procedures without any additional cost to the Owner.

203.3.1.1.1 Bottom Preparation: Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 3/4 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

203.3.1.1.2 Removal of Unyielding Material: Where over depth is not indicated, and unyielding material is encountered in the bottom of the trench, remove such material eight (8) inches below the required grade and replace with suitable materials as provided Section 201.

203.3.1.1.3 Removal of Unstable Material: Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in Section 201. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Owner.

203.3.1.1.4 Excavation for Appurtenances: Provide excavation for manholes, catch-basins, inlets, or similar structures of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Remove loose disintegrated rock and thin strata. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete is to be placed.

203.3.1.2 Rock Excavation: Reference Section 201 for the description of rock excavation. All stone or boulders less than eight (8) cubic feet in volume will be classified as earth. The Engineer shall, in all cases, be advised if blasting is deemed necessary for removal of material encountered in the trench. Normally blasting will not

be permitted in the City limits. That portion of the trench bottom excavated in rock shall be over-excavated a minimum of four (4) inches below all pipe elevations and backfilled to trench invert grade with suitable granular material approved by the Engineer.

203.3.1.3 Jacking, Boring, and Tunneling: Shall conform to Section 507 of these specifications.

203.3.1.4 Stockpiles: Stockpiles of satisfactory and wasted materials shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared and grubbed. Excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Owner.

203.3.2 BRACING AND SHEETING

In congested areas where narrowness of right-of-way, traffic, other installed utility lines, buildings or structures prevents sloping of trench banks, it shall be the Contractor's responsibility to install sheet piling or operate a trench box or caisson to maintain trench widths to protect existing improvements and work personnel. The Contractor will not be compensated for replacement of any improvements damaged due to his failure to provide proper bracing, sheeting, or other restraining devices. Sheeting, bracing, or other restraining devices shall not be removed after pipe lines are laid until sufficient backfill is in place to protect the pipe or existing improvements from damage by slides or cave-ins. Should it become necessary to leave sheeting or piling in place, it shall be cut-off at least four (4) feet below the ground.

203.3.3 BACKFILLING

Backfilling operations shall be performed in accordance with Section 201 and normally be carried immediately behind the pipe laying operations. Long stretches of open trench will not be permitted. All pits that will require future access for additional project operations shall be temporarily backfilled. The Contractor shall be prepared at all times to take measures to prevent flood damage to facilities connected with this project, and private or public property.

203.3.3.1 Trench Backfill: Backfill trenches to the grade shown. Backfill the trench at least three (3) feet above the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test.

203.3.3.1.1 Replacement of Unyielding Material: Replace unyielding material removed from the trench with select granular material or initial backfill material.

203.3.3.1.2 Replacement of Unstable Material: Replace unstable material removed from the trench or excavation with select granular material placed in layers not exceeding eight (8) inch loose thickness.

203.3.3.1.3 Bedding and Initial Backfill: Provide bedding of the type and thickness shown in the project drawings. Place bedding material and compact it with approved tampers to a height of at least one foot above the utility pipe conduit or structure. Bring up the bedding evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Compact backfill to percentage of standard proctor as called for.

203.3.3.1.4 Final Backfill: Fill the remainder of the trench, except for special materials for roadways, sidewalks and other structures with satisfactory material. Place backfill material and compact to 95 percent standard proctor.

203.3.3.1.5 Flowable Backfill: Flowable fill as defined in Section 204 may be used for bedding, initial backfill, and final backfill as called for in project documents or at Contractor's choice. The consistency of the backfill shall be such that all voids are filled with minimum rodding or vibrating but not so wet as to cause excessive shrinkage, prolonged set times or detrimental reduction in strength. Cured flowable fill shall have compressive strengths greater than compacted soil as specified on the project drawings yet shall be suitable for future excavation by conventional methods. Test methods t conform to NMDOT 516.2.10.

203.3.3.1.6 Granular Material: In areas where the natural material is encountered in the trench bottom meets the specified gradation requirements in Section 204 for granular fill, over excavation and placing of granular material will not be required, but accurate shaping and grading of the trench bottom to provide the above cited pipe support shall be carried out.

203.3.4 PAVEMENT CUT AND PATCHES

Pavement patches and cuts shall conform to applicable Sections of these specifications.

203.3.5 EXISTING UTILITIES

The Contractor shall call for utility "locates" by the utility companies prior to any construction activities. The Contractor should familiarize himself of the fees involved for the initial and return "locates". The Contractor shall, in addition, expose certain existing lines which could cause grade, alignment, or tie-in problems for the proposed facilities.

The Contractor shall exercise due care to ensure that existing water and sewer laterals and service connections are not disturbed or damaged. Any laterals or service connections

damaged as a result of the Contractor's operations shall be replaced with materials of like kind or as specified. Repaired and/or replaced laterals and service connections shall not be covered until inspected and approved by the Owner or his representative. The Contractor shall, after locates are provided by City Personnel, or others, carefully probe for and locate service lines on the blind side or trench side of existing mains. It is recommended that the Contractor have on hand for the project, an electronic device suitable for locating underground copper or ferrous lines. Contractor shall be responsible for tying in all service lines to new main construction.

Contractor shall work whatever hours are required to repair and replace damaged or cut water and sewer services or mains back into operation with a minimum of inconvenience to the user.

Contractor shall use extreme caution when trenching in areas with sewer service lines so that flow from cut service lines does not come near newly laid water pipe. Water pipe that is infiltrated by sewage will be rejected and shall be removed. Workmen shall have available, at all times, potable water and soap to wash up after working on sewer lines. Diluted chlorine solution shall also be available at all times to wipe down water pipe and fittings if deemed necessary.

203.3.6 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

203.3.6.1 Waterlines: Trenches shall be of a depth to provide a minimum cover of four (4) feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

203.3.6.2 Electrical Distribution Systems: Direct burial cable and conduit or duct line shall have a minimum cover of two (2) feet for secondary services and four (4) feet for primary services.

203.3.6.3 Plastic Marking Tape: Warning tapes shall be installed 1 foot above the pipe, at a depth of approximately 2 1/2 feet below finished grade unless otherwise shown. Wire shall be installed under or wrapped around pipe.

203.3.7 TESTING

Testing shall be in accordance with Section 201.

203.3.8 DE-WATERING

At the cost of the Contractor, the Contractor shall furnish all equipment, perform all operations required to remove all water from trenches or other parts of the work in accordance with Section 201, and fully protect the work from slides or cave-ins by

installation, shoring or other restraining. De-watering and/or shoring shall be continued until all work below the water table has been completed and backfilled. Water from de-watering operations shall be disposed of as directed by the Engineer.

203.3.9 ACCESS TO PUBLIC STREETS, ALLEYS AND RIGHTS-OF-WAY, RAILROAD AND PRIVATE PROPERTY

Work to be performed under this project shall be carried out in a manner that will cause the least inconvenience to public travel and damage to adjacent private property. In general, the Contractor will not be permitted to completely close off any public or private streets, driveways, alleys or other routes or travel by the public. Closure of any public route of travel will be only after obtaining permission of the City Director of Public Works, Street Superintendent, or County Road Superintendent. Such closure shall be for the minimum period necessary for construction. Where private property is served by two (2) driveways or wide frontage on public rights of way, access will be provided at all times. In some cases, it may be necessary that the Contractor construct temporary roads or driveways. Temporary access routes shall be properly constructed and maintained by the Contractor.

Contractor shall place and maintain barricades, warning lights, and signs as required to inform and protect the general public and project workmen. Contractor shall be courteous and attempt to work with businesses and residents to the fullest extent possible until the project is complete.

Traffic Routing Plans for work within the City shall be submitted to the City Director of Public Works for approval. The plan shall address each phase of construction. Traffic routing plans for work within NMDOT rights-of-way will be contained in the Contract Documents.

The Contractor shall water the streets for dust control when requested by the City or by the Engineer. In addition, the Contractor shall "broom" the streets as required during the time period between pipe installation and patching.

All work on railroad property shall be done in such a manner as to least interfere with rail traffic, railroad workmen and railroad lessee business operations. All work shall be planned in close coordination with appropriate railroad officials and lessee representatives. No work shall be performed on railroad property unless a permit is obtained.

203.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the specifications shall be as set forth in the Special Conditions.

204 FILL MATERIALS – INDEX

204 FILL MATERIALS

204.1 GENERAL

204.1.1 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the Work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 201, General Earthwork
III. Section 203, Trenching, Excavation, and Backfilling
IV. Section 301, Cast-In-Place Concrete

204.1.2 SUBMITTALS

Engineer approval is required for submittals. The following shall be submitted in accordance with Section 101 of the Specifications.

Certification: Engineer's Approval

204.1.2.1 Granular Fill: Contractor to provide certified test reports made by an independent testing laboratory indicating that material meets or exceeds the requirements of these specifications. The term "granular fill" shall apply to granular fill, granular backfill, or granular embankment.

204.1.2.2 Native Rock Free Fill: Contractor to provide certified test reports made by an independent testing laboratory indicating that materials meet or exceed the requirements of these specifications. The term "native rock free fill" shall apply to native rock free fill, native rock free backfill, or native rock free embankment.

204.1.2.3 Test Reports: Engineer's Approval

I. Flowable Fill Mix Design
II. Filter Aggregate

204.2 MATERIALS

204.2.1 GRANULAR FILL

Granular fill material shall be unfrozen gravel, sandy gravel or gravelly sand free of organic material, loam, trash, snow, ice or other objectionable material and shall have a plasticity index of less than or equal to 12 (per ASTM D4318) and shall conform to the gradation limits:

Table 1:

Sieve Size	Percent Passing
6 inch	100
4 inch	85-100
¾" inch	70-100
No. 4	50-100
No. 200	40 (max)

The maximum allowable aggregate size shall be 3/8-inches, or the maximum allowable size recommended by the pipe manufacturer, whichever is smaller.

204.2.2 NATIVE ROCK FREE FILL

Native fill shall not contain rocks, broken concrete, masonry rubble, asphalt pavement, or any material larger than six (6) inches in any one direction. Native fill shall have a plasticity index of less than 20 and shall conform to Table 2 limits:

Table 2:

Sieve Size	Percent Passing
No. 200	15-70

204.2.3 FLOWABLE FILL MIX DESIGN

Flowable Fill shall conform to requirements of ADOT Highway & Bridge Construction Specifications, 2021 Edition except as modified below.

Flowable backfill may be composed of sand, crusher fines, fly ash, other suitable materials, and Portland Cement. The consistency of the backfill shall be such that all voids are filled with minimum rodding or vibrating but not so wet as to cause excessive shrinkage, prolonged set times, or detrimental reduction in strength. Cured flowable fill shall have compressive strengths greater than compacted soil as specified on the project drawings yet shall be suitable for future excavation by conventional methods. Flowable Fill Mix Design shall be established in accordance with the following limits:

204.2.3.1 Strength: Strength of flowable fill shall be 50 – 150 pounds per square inch (psi) as described above per ASTM D4832 (except that in some cases additional cement may be added to accelerate initial set or increase strength).

204.2.3.2 Cement: 50 - 94 lb/CY as required to meet strength requirement above (except that in some cases additional cement may be requested to increase strength. Cement shall comply with Section 301 and shall be low alkali type I or II.

204.2.3.3 Fly Ash: Class F fly ash shall be used, no blends of other classes. Fly Ash shall comply with Section 301.

204.2.3.4 Aggregates: Aggregates shall comply with Section 301 and conform to the following requirements:

Fine aggregate shall provide a uniform mixture and have the gradation characteristics as shown in Table 3:

Table 3:

Sieve Size	Percent Passing
3/8 inch	95-100
No. 4	80-100
No. 8	60-95
No. 16	45-80
No. 30	25-60
No. 50	5-45
No. 100	5-35
No. 200	0-30

204.2.3.5 Slump: Five (5) inches – Eight (8) inches

204.2.3.6 Water: Water shall be portable water from municipal or another approved source.

204.2.3.7 Temperature: Air temperature at the time of placement shall be 35 degrees Fahrenheit and rising. If air temperature is less than 40 degrees Fahrenheit then flowable fill is to be at least 50 degrees Fahrenheit. If forecast temperatures are to be less than 35 degrees Fahrenheit after placement then fill is to be covered by a minimum of 12 inches of loose soil for a period of three (3) days or until temperatures rise or until load application tests indicate initial set has been achieved.

204.2.3.8 Load Application Tests: Load application tests shall be administered per ASTM D6024-07 (the ball drop test).

Note: Flowable Fill materials are subject to approval by the State Materials Bureau and the Owner's appointed Project Manager.

204.3 EXECUTION

204.3.1 NATIVE ROCK UTILIZATION

204.3.1.1 Slope Cover: Rock excavated from proposed site development to be placed in designated areas as a means of proper disposal and for the prevention of erosion of

slopes. Rock dust and fines to be held to a minimum. Rock size to range from 6 inches to 24 inches. Trees to remain amongst the rock placement to the extent possible.

Rock to be placed by hand and machine to a depth not to exceed 24 inches. Finished slope cover to have the appearance of having been "placed," rather than dumped.

204.3.1.2 Rock Fill: Rock excavated from proposed site material may be placed in areas requiring fill when approved by the Engineer. The rock may be contained in a mixture of soil and rock dust fines. The rock fill shall not encroach on any portion of what is designated as a pipeline trench.

Excavated rock to be used in areas approved for fill shall be placed in uniform layers not to exceed 24 inches and "walked in" with heavy equipment. When soil or rock dust is the dominant component water shall be added and processed to aid in compaction. The finished surface shall be suitable for dressing to site grading requirements.

204.3.2 PLACING FLOWABLE FILL

The flowable fill shall be placed in a uniform manner that will prevent voids or segregation of the bedding and filling material. Culvert or pipe shall be secured from movement. The flowable fill shall be placed by direct discharge from a ready-mix truck, pumping, or other approved method. Flowable fill shall have a placed minimum thickness of six (6) inches. It shall not be placed in standing water and shall be protected from flooding for at least 24 hours after placement. The flowable fill shall not be placed on frozen ground nor during rain. Newly placed flowable fill shall be undisturbed by construction activities for at least 24 hours after placement or as required to support subsequent construction activities. Backfill material shall not be placed over newly placed flowable fill until initial set has been reached as determined by ASTM D6024-07, ASTM D1558, or approved by Engineer. All testing must be done in the presence of Engineer.

204.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the specifications shall be as set forth in the Special Conditions.

205 EROSION CONTROL – INDEX

205 EROSION CONTROL

205.1 GENERAL

205.1.1 DESCRIPTION

I. The work under this specification includes furnishing, assembling, filling and tying open wire mesh rip-rap rectangular compartmented gabions and mattresses placed on a prepared surface of geotextile materials, as specified and detailed in accordance with the lines, grades, and dimensions shown or otherwise established in the field.

   Wire Enclosed Rip-Rap shall be Class A wire enclosed per NMDOT specifications. Wire Enclosed Rip-Rap shall form a uniform, flexible, permeable grade control structure(s).

II. Gabions and mattresses are wire mesh containers of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the project site to form flexible, permeable, monolithic structures.

III. Non-enclosed Rip-Rap

IV. Erosion control blankets and erosion control mats will be used where asked for on the project drawings.

205.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the Work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 107, Storm Water Pollution Prevention
III. Section 108, Water Pollution Control
IV. Section 201, General Earthwork
V. Section 202, Clearing and Grubbing
VI. Section 204, Fill Materials
VII. Section 206, Geotextile Fabric and Geogrids

205.1.3 SUBMITTALS

Submit the following in accordance with Section 101:

205.1.3.1 Samples: Samples of the materials used to fabricate the gabions or mattresses shall be furnished to the Engineer prior to assembly of units onsite.

205.1.3.1.1 Stone: Engineer's Approval. Samples of stone for the items listed below shall be submitted prior to delivery.

I. Wire Enclosed Rip-Rap
II. Gabions or Mattresses
III. Non-Enclosed Rip-Rap

205.1.3.1.2 Stakes: Engineer's approval. Description of stakes to be used for the items listed below shall be submitted prior to delivery.

I. Wire Enclosed Rip-Rap
II. Gabions or Mattresses
III. Non-Enclosed Rip-Rap
IV. Alternative Wire Fasteners

205.1.3.1.3 Erosion Control Blankets and Reinforcement Mats: Engineer's approval. Description of blanket to be used shall be submitted prior to delivery. Provide engineer with manufacturer's examples of blankets to be used.

205.1.3.2 Test Reports: Supply test reports for the following:

I. Wire Enclosed Rip-Rap
II. Gabions or Mattresses
III. Alternative Wire Fasteners
IV. Non-Enclosed Rip-Rap
V. Erosion Control Blankets and Reinforcement Mats

Furnish to the Engineer, in duplicate, test reports or records that have been performed during the last year on all materials from each shipment delivered to the site. All material contained within the shipment shall meet the composition, physical, and manufacturing requirements stated in this specification.

205.1.3.3 Certifications: A certificate or affidavit, signed by a legally authorized official of the supplier of the stone fill, natural filter material, or other, that it meets the quality required and gradation limits specified.

I. Wire Mesh: Engineers approval. Contractor to provide certified test reports made by an independent testing laboratory indicating that material meets or exceeds the requirements of these specifications.
II. Stone Fill
III. Filter Material
IV. Gabion Mattresses
V. Erosion Control Blankets and Reinforcement Mats

205.1.4 DELIVERY, STORAGE, AND HANDLING

205.1.4.1 Gabions and Rip-Rap: Gabions and mattresses shall be delivered with all components mechanically connected at the production facility with the exception of the mattress lid, which is produced separately from the base. All gabions and mattresses are supplied in the collapsed form, either folded, bundled, or rolled, for shipping. Bundles are banded together at the factory for ease of shipping and handling. Mattress bases and lids may be packed in separate bundles.

I. Mattress lids may be supplied either as individual units (bundled) or in roll form. Lacing wire shall be shipped in coils with a diameter of the coil approximately two (2) feet. Fasteners shall be shipped in boxes. Preformed stiffeners shall be shipped in bundles.
II. Gabions and mattresses shall be delivered to the jobsite labeled in bundles. Labels shall show the dimensions of the gabions or mattresses received, the number of pieces and the color code.

205.1.4.2 Erosion Control Blankets and Reinforcement Mats: Prior to delivery of materials, submit certificates of compliance attesting that materials meet the specified requirements. Store materials in designated areas to keep materials protected from the elements, direct exposure, and damage. Do not drop containers from trucks. Material must be free of defects that would void required performance or warranty. Deliver geosynthetic binders and synthetic soil binders in the manufacturer's original sealed containers and store in a secure area.

I. Furnish erosion control blankets and geotextile fabric in rolls with suitable wrapping to protect against moisture and extended ultraviolet exposure prior to placement. Label erosion control blanket and geotextile fabric rolls to provide identification sufficient for inventory and quality control purposes.

II. All synthetic grids, synthetic sheets, and articulating cellular concrete block grids must be sound and free of defects that would interfere with the proper placing of the block or impair the strength or permanence of the construction. Minor cracks in synthetic grids and concrete cellular block, incidental to the usual methods of manufacture, or resulting from standard methods of handling in shipment and delivery, will not be deemed grounds for rejection.

III. Inspect seed upon arrival at the jobsite for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, must be rejected.

205.1.5 WEATHER CONDITIONS

Perform erosion control operations under favorable weather conditions; when excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work must be stopped as directed. When special conditions warrant a variance to earthwork operations, submit a

revised construction schedule for approval. Do not apply erosion control materials in adverse weather conditions.

205.2 MATERIALS

205.2.1 WIRE ENCLOSED RIP-RAP

205.2.1.1 Stone for Wire Enclosed Rip-Rap: Stone used for Wire Enclosed Rip-Rap shall be rocks or rough quarry stone with a percent wear of not more than 60 percent as determined by AASHTO T96 and a soundness loss of not more than 21 percent as determined by AASHTO T104 using a magnesium sulfate solution with a test duration of five (5) cycles. Stone shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

205.2.1.2 Wire: The wire mesh shall be fabricated so as to be non-raveling and furnished in such lengths and widths so that the number of splices is kept to a minimum. The composite wire mesh shall be in conformance with the NMSHTD specification Section 602.35 wire mesh testing and certification.

Wire shall conform to the requirements of ASTM A641 and shall have a Class 3 zinc coating. Zinc coating shall be in accordance with ASTM A90. Wire shall be 11 1/4 Gauge or larger. Wire mesh openings shall be uniform in size with opening size no more than 4 3/4 inches in the largest dimension but must have at least one dimension of 3 1/4 inches or less.

205.2.1.3 Stakes: Stakes shall be steel railroad rails, standard weight galvanized steel pipe or steel angles.

I. Steel railroad rails shall have a unit weight of at least 30 pounds per yard.
II. Standard weight galvanized steel pipe shall be four (4) inches in outside diameter.
III. Steel angles shall be 4 x 4 x length called for in inches in dimension.

205.2.1.4 Geotextile: Geotextile fabric, including threads, shall conform to Section 206 of these Specifications.

205.2.2 GABIONS

205.2.2.1 Double Twisted Mesh Gabions and Mattresses: Double twisted wire mesh gabions and mattresses shall be manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Gabion and mattress sizes, wire diameters, mesh opening sizes, and tolerances shall comply with the requirements of ASTM A 975 (Tables 1, 3, 4, 5, and 6). Gabions and Mattresses shall meet the following:

205.2.2.1.1 Classification: Classified according to the wire coating, which is applied prior to manufacturing the mesh. Coating styles are as follows.

205.2.2.1.1.1 Style 1: Wire mesh made from wire which is zinc coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are produced from zinc-coated wire. Style 1 for the wire coating is normally recommended for:

I. Permanent gabion or mattress structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unaltered over time;

II. Temporary gabion or mattress structures, for works in moderately aggressive environments, depending on the minimum design life of the structure.

205.2.2.1.1.2 Style 2: Wire mesh made from wire which is coated with Zn-5Al-MM before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from Zn-5Al-MM coated wire. Gabions and mattress shall be Style 2 unless otherwise called for in project documents. Style 2 for the wire coating is normally recommended for:

I. Permanent gabion or mattress structures, for works installed in moderately aggressive environments;

II. Temporary gabion or mattress structures, for works in aggressive environments, depending on the minimum design life of the structure.

205.2.2.1.2 Metallic Coating: The coating weights shall conform to the requirements of ASTM A 641/A 641M, Class 3 (Style 1) or ASTM A 856/A 856M (Style 2).

205.2.2.1.3 Wire Tensile Strength: The tensile strength of the wire used for the double twisted mesh, lacing wire, and stiffener, when tested in accordance with test methods and definitions ASTM A 370, shall be in accordance with the requirements of ASTM A 641/A 641M (Style 1) or ASTM A 856/A 856M (Style 2) for soft temper wire.

205.2.2.1.4 Mesh Strength and Panel to Panel Joint Strength: The minimum strength requirements of the mesh, selvedge wire to mesh connection, panel to panel connection, and punch test, when tested in accordance with ASTM A 975 Section 13.1, shall be as shown in Table 1. The strength values reported in pound per foot (lb./ft) are referred to the unitary width of the specimen. The panel to panel test shall demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire or the ring spacing for ring fasteners used. The same number of wire revolutions or ring spacing shall be used in the field installation. Pleating the based panel to obtain internal panels is prohibited.

TABLE 1: MINIMUM STRENGTH REQUIREMENTS OF MESH AND CONNECTIONS

Test Description	Gabions, metallic coated (lb./ft)	Revet mattresses metallic coated (lb./ft)
Tensile Strength parallel to twist	3500	2300
Tensile Strength perpendicular to twist	1800	900
Connection to selvedges	1400	700
Panel to panel (using lacing wire or ring fasteners)	1400	700
Punch Test	6000	4000

205.2.2.2 Alternative Wire Fasteners for Gabions and Mattresses: Subject to approval of the Engineer, alternative fastening systems may be used in lieu of lacing wire. Alternative fasteners to lacing wire recommended for woven wire gabions and mattresses, according to ASTM A 975, are steel ring fasteners for metallic coated gabions and mattresses. Ring fasteners for woven wire gabions and mattresses shall comply with the minimum requirements indicated in Paragraph 205.2.2.2.1 below, and they shall develop a minimum panel to panel joint strength as indicated in Table 1. Provide a complete description of the fastener system and a description of a properly installed fastener, including drawings or photographs if necessary. Provide test results that demonstrate that the alternative-fastening system meets the requirements of the specifications, according to the following criteria:

I. That the proposed fastener system can consistently produce a panel to panel joint strength as indicated in the Table 1 for double twisted wire mesh gabions;
II. That the proposed fastener system does not cause damage to the protective coating on the wire;
III. That the Contractor has the proper equipment and trained employees to correctly install the fasteners;
IV. That proper installation can be readily verified by visual inspection. Samples of wire fasteners with their certified test records shall be submitted at least 10 days in advance to the Engineer for approval.

205.2.2.2.1 Ring Fasteners: The tensile strength of the zinc-coated steel wire used for fasteners shall be in accordance with the requirements of ASTM A 764. Any fastener system shall give the number of fasteners required to comply with Table 1 of this specification, in accordance with ASTM A 975 for woven wire gabions. Ring

fasteners shall not be installed more than four (4) inches apart. Each fastener type shall be closed, and the free ends of the fastener shall overlap a minimum of one (1) inch. The manufacturer or supplier shall state the number of fasteners required for all vertical and horizontal connections for single and multiple basket joining.

205.2.2.2.2 Spiral Binders: Spiral binders are defined as a length of metallic coated steel wire preformed into a spiral, used to assemble and interconnect empty gabion and/or mattress units, and to close and secure stone-filled units. Spiral binders shall be fabricated with the same wire and coating style as the wire mesh.

205.2.2.3 Testing: Test records made within one year by certified laboratories. Samples of wire fasteners and samples of material for fabricating the gabions and mattresses with their certified test records shall be submitted at least 10 days in advance to the Engineer for approval.

205.2.2.4 Stone Fill: For gabions and mattresses, the ability to function properly depends upon their stability, which is partly dependent upon the rocks filling them. Rock sizes should be chosen to prevent them from falling through the mesh of the gabions or mattresses. The rock has to also withstand natural weathering processes during the life of the project that would cause it to breakdown to sizes smaller than the wire mesh opening dimensions. Rock to fill gabions and mattresses shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

205.2.2.4.1 Delivery: Rock shall be delivered to the work site in a manner to minimize its reduction in size (breakdown) during the handling of the rock and be placed and secured within the assembled and interconnected gabion or mattress.

205.2.2.4.2 Sources: The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. The inclusion of more than five (5) percent by weight of dirt, sand, clay, and rock fines will not be permitted. Rock may be of a natural deposit of the required sizes or may be crushed rock produced by any suitable method and by the use of any device that yields the required size limits chosen in Table 2 of this specification.

205.2.2.4.3 Properties: Rocks shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. All stone shall be obtained from one source.

205.2.2.4.4 Stone Quality: Stone fill, crushed stone, shall meet the quality requirements of ASTM C 33/C 33M, and freezing and thawing requirements of ASTM D 312 for the region of the United States in which the structure will be constructed.

205.2.2.4.5 Gradation: Gradation of stone for gabions shall be performed every 1000 tons placed under this contract in accordance with ASTM C 136. Sizes of rock to fill gabions and mattresses are chosen based on the mesh sizes, the structure's thickness,

and within the limits shown in Table 2 of this specification. Within each range of sizes, the rock shall be large enough to prevent individual pieces from passing through the mesh openings. Each range of sizes may allow for a variation of five (5) percent oversize rock by weight, or five (5) percent undersize rock by weight, or both within each gabion of mattress compartment.

205.2.2.4.5.1 Oversize Rock: In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each gabion compartment and two or more layers of rock within each mattress compartment dependent upon the height of the mattress.

205.2.2.4.5.2 Undersize Rock: In all cases, undersize rock shall be placed within the interior of the gabion or mattress compartment and shall not be placed on the exposed surface of the structure.

TABLE 2: REQURIED ROCK GRADATION FOR GABIONS AND MATTRESSES

Type of Structure	Thickness (height), inch	Rock Sizes, inch
Mattresses	6 – 9	3 – 5
Gabions	18 or higher	4 – 8

205.2.3 NON-ENCLOSED RIP-RAP

205.2.3.1 Stone for Non-Enclosed Rip-Rap: Provide non-erodible rock not exceeding 15 inches in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness of one (1) foot. Stone used for Wire Enclosed Rip-Rap shall be rocks or rough quarry stone with a percent wear of not more than 60 percent as determined by AASHTO T96 and a soundness loss of not more than 21 percent as determined by AASHTO T104 using a magnesium sulfate solution with a test duration of five (5) cycles. Stone shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

205.2.3.2 Geotextile: Geotextile fabric, including threads, shall conform to Section 206 of these Specifications.

205.2.4 EROSION CONTROL BLANKETS

Erosion Control Blankets are to be degradable and able to hold the natural landscape, seed and soils in place. As vegetation begins to grow, and as the blankets are no longer needed, the blankets are to decompose. Erosion control blankets must be a machine-produced mat consisting the material described in the manufacture's recommendations. The blanket must be of consistent thickness with the inside materials evenly distributed over the entire area of the mat. The netting shall consist of photodegradable polypropylene.

The Hancor® product(s) in Table 3 or equal shall be used where indicated on the project design drawings.

TABLE 3: EROSION CONTROL BLANKET TYPE(S) AND SPECIFICATIONS

Hancor Landlok S1®			
Thickness ASTM D1777	0.11 inches	Life	< One (1) year
Tensile Strength ASTM D 5035	50 x 65 lb./ft	Use	Low-flow & moderate slopes
Elongation ASTM D 5035	20%	Fill	Pure wheat straw fibers
Mass per Unit Area	8.5 oz/yd^2	Netting	Top side only
Hancor Landlok S2®			
Thickness ASTM D1777	0.25 inches	Life	Up to 1 year
Tensile Strength ASTM D 5035	75 x 75 lb./ft	Use	Low-flow & moderate slopes
Elongation ASTM D 5035	25%	Fill	Pure wheat straw fibers
Mass per Unit Area	8.8 oz/yd^2	Netting	Top and bottom sides
Mass per Unit Area	10.6 oz/yd^2	Netting	leno-weave jute biodegradable

205.2.5 REINFORCEMENT MATS

Reinforcement mats are to be used in areas to enhance the natural ability of vegetation to protect soil from erosion. These are permanent erosion control devices for slopes and channels that need more stabilization than the natural vegetation can offer. The mats can help accelerate vegetative establishment and then anchor the mature plants to the soil.

The Hancor® product(s) in Table 4 or equal shall be used where indicated on the project design drawings.

TABLE 3: REINFORCEMENT MAT TYPE(S) AND SPECIFICATIONS

Hancor Landlok TRM 436®			
Thickness ASTM D1777	0.35 inches	Use	Economical version of 450®
Resiliency ASTM D1777	80%	Fill	3D web of polyolefin fibers
Porosity	96.50%	Netting	Top and bottom nets
Ground Cover Factor	60%		
Tensile Strength ASTM D 5035	145 x 110 lb./ft		
Elongation ASTM D 5035	50% maximum		
Mass per Unit Area	8.0 oz/yd^2		
UV Resistance @ 1000 hours	80%		

205.3 EXECUTION

205.3.1 WIRE ENCLOSED RIP-RAP

205.3.1.1 Site Preparation: Area to receive fabric shall be cleared and graded as required within the contract documents. Contractor is to remove all large, sharp objects which include but are not limited to rocks, cut trees, shrubs, glass, etc., which may damage fabric. Contractor is to ensure that all areas to be covered are stable and compacted to that indicated on the Contract Drawings.

205.3.1.2 Fabric Placement: Fabric shall be placed in accordance with Section 206.

205.3.1.3 Wire Enclosed Rip-Rap Placement: Stones shall be enclosed on all sides with wire mesh and shall be constructed in accordance with the details shown in the Contract Documents. Wire Enclosed Rip-Rap stones shall be placed to form a continuous blanket of the minimum thickness indicated on the Contract Drawings. Stones shall be placed with their long axis parallel to the toe of the slope and shall have a stable bearing upon the underlying soil or stones. Stone sizes are to be no less than four (4) inches in the shortest dimensions and are to be between 1/6 – 2/3 cubic feet by volume. The joints between larger stones shall be as close as practical and shall be filled with smaller slope. The Contractor shall use extreme care in placing stones on the geotextile fabric so not to tear or otherwise damage the fabric. The Contractor is to ensure that a layer of fabric is placed at the interface between the sloped and stone surfaces as shown on the Contract Drawings.

The wire mesh shall be drawn tightly against the stones on all sides. Edges of wire mesh shall be connected using lacing wire (13 1/2 GA or larger) and shall be double loop

woven at adjacent edges to ensure that the strength and flexibility at the point of connection is equal to or greater than that of the mesh.

Lacing shall be continuous as far as practicable and shall pass through each mesh opening.

Galvanized tie wire (9 GA or larger) shall be provided at two (2) feet on center each way.

205.3.2 GABIONS

205.3.2.1 Foundation Preparation: Foundation preparation shall not take place on frozen or snow-covered ground. After excavation or stripping, to the extent indicated on the drawings or as directed by the Engineer, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any debris that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the Engineer shall inspect the prepared foundation surface, and no material shall be placed thereon until that area has been approved.

205.3.2.2 Assembly:

205.3.2.2.1 Double Twisted Wire Mesh Gabions: The gabions shall be opened and unfolded one by one on a flat, hard surface. Gabion units over six (6) feet in length usually have an extra shipping fold, which must be removed. The sides, ends and diaphragms shall be lifted into a vertical position to form an open box shape. The back and the front panels of the gabion shall be connected to the end panels and center diaphragms. The top corner of the end panels and center diaphragms have a selvedge wire extending approximately four (4) inches out from the corner edge. The end panels and the diaphragms shall be raised to a vertical position and the selvedge wire shall be wrapped around the edge wire of the top and back panels.

205.3.2.2.2 Double Twisted Wire Mesh Revet Mattresses**:** The mattress shall be laid on a flat, hard surface. When the units are unfolded for assembly, depending on their length, they will have one or two shipping folds, which must be removed. The double flap of the side panel shall be folded in and wired to the diaphragm. At the corners, the end flaps shall be folded along the sides and the joint laced up. Each revet mattress shall be assembled individually, by erecting the sides, ends and diaphragms, ensuring that all creases are in the correct position and the tops of all sides are level.

205.3.2.3 Lacing Operations:

205.3.2.3.1 Double Twisted Wire Mesh Gabions and Mattresses: Lacing wire or ring fasteners are permitted to either lace double twisted wire mesh gabions or Revet mattresses.

I. When using lacing wire, a piece of wire 1.2 to 1.5 times the length of the edge to be laced shall be cut off. If the edge of the basket is three (3) foot long, no more than four (4) to five (5) feet of wire should be used at a time to lace. For vertical joints, starting at the bottom end of the panel, the lacing wire shall be twisted and wrapped two times around the bottom selvedge and double and single loops shall be alternated through at intervals no larger than four (4) to six (6) inches. The operation shall be finished by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is normally recommended.

II. When steel wire ring fasteners are used, the rings shall be installed at the top and bottom connections of the end and center diaphragms. The ring spacing shall be based on the minimum pull part strength as specified in Table 1 of this specification. In any case, the maximum ring spacing along the edges shall not exceed six (6) inches. The use of either a mechanical or a pneumatic fastening tool for steel wire ring fasteners is required.

205.3.2.4 Installation and Filling: Empty gabion and mattress units shall be assembled individually and placed on the approved surface to the lines and grades as shown or as directed, with the sides, ends, and diaphragms erected in such a manner to ensure the correct position of all creases and that the tops of all sides are level. All gabion units shall be properly staggered horizontally and vertically as shown in the construction drawings. Finished gabion or mattress structures shall have no gaps along the perimeter of the contact surfaces between adjoining units. All adjoining empty gabion units shall be connected along the perimeter of their contact surfaces to obtain a monolithic structure. All lacing wire terminals shall be securely fastened. All joining shall be made through selvedge-to-selvedge or selvedge-to-edge wire connection; mesh-to-mesh or selvedge-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked, and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selvedge or edge wire.

I. The initial line of basket units shall be placed on the prepared filter layer surface or foundation and adjoining empty baskets set to line and grade, and common sides with adjacent units thoroughly laced or fastened. They shall be placed in a manner to remove any kinks from the mesh and to a uniform alignment. The basket units then shall be partially filled to provide anchorage against deformation and displacement during the filling operation. The stone shall be placed in the units as specified in Paragraph 205.2.2.4.

II. Undue deformation and bulging of the mesh shall be corrected prior to further stone filling. Care shall be taken, when placing the stone by hand or machine. All visible faces shall be filled with some hand placement to ensure a neat and compact appearance and that the void ratio is kept to a minimum.

III. Gabions and mattresses shall be uniformly overfilled by about one (1) to two (2) inches to compensate for future rock settlements. Gabions and mattresses can be filled by any kind of earth-filling equipment, such as a backhoe, gradall, crane, etc. The maximum height from which the stones may be dropped into the baskets shall be three (3) to four (4) feet.

205.3.2.4.1 Double Twisted Wire Mesh Gabions: After the foundation has been prepared, the pre-assembled gabions shall be placed in their proper location to form the structure. Gabions shall be connected and aligned before filling the baskets with rock. All connections (panel-to-panel) and basket-to-basket shall be already carried out as described in Paragraph 205.3.2.2. Stone fill shall have a gradation of four (4) to eight (8) inches, as described in Paragraph 205.2.2.4.5, and shall be placed in one (1) foot lifts. Cells shall be filled to a depth not exceeding one (1) foot at a time. The fill layer should never be more than one (1) foot higher than any adjoining cell. Stiffeners or internal crossties shall be installed in the front and side of the gabions at 1/3 and 2/3 of the height for three (3) feet high gabions, as the cell is being filled. Stiffeners shall be installed in the center of each cell. In 1.5-foot-high units, stiffeners or internal crossties are not required. Internal crossties, or alternatively the preformed stiffeners, shall be looped around three twisted wire mesh openings at each basket face and the wire terminals shall be securely twisted to prevent their loosening. The number of voids shall be minimized by using a well-graded stone to achieve a dense, compact stone fill. All corners shall be securely connected to the neighboring baskets of the same layer before filling the units. When more than one layer of gabions is required, for the individual units to become incorporated into one continuous structure, the next layer of gabions shall be connected to the layer underneath after this layer has been securely closed. Gabions shall be uniformly overfilled by about one (1) inch to two (2) inches to compensate for future rock settlements.

205.3.2.4.2 Double Twisted Wire Mesh Revet Mattresses: After being assembled, the revet mattresses shall be placed in their proper location and securely attached to the adjacent units. For structural integrity, all adjoining empty units shall be connected by means of lacing wire or ring fasteners along the edges of their contact surfaces to form a monolithic structure. Revet mattresses shall be placed and securely connected while empty. The filling shall be done unit by unit; however, several units can be pre-assembled prior to filling the units. Revet mattress units shall be filled with hard, durable, clean stone having a gradation as indicated in Paragraph 205.2.2.4.3. Care shall be taken to ensure that diaphragm tops are accessible for wiring. On slopes, the revet mattress shall be laid with the six (6) foot dimension (width) longitudinally to the slope and progressing up the slope, except for small ditches or where otherwise specified in the project. When the installation is performed on a slope, the filling of

the baskets shall start from the lower side of the bank. Where revet mattresses are to be placed on steep slopes (2V to 3H), the units shall be secured by hardwood pegs driven into the ground just below the upper end panel, at six (6) foot centers, or as specified in the project. When the revet mattress is to be placed over a geotextile, care shall be taken to ensure that any projecting ends of wire are bent upward to avoid puncturing or tearing the cloth. Lids shall be securely connected to the ends of the mattress and to the top sides and diaphragms using alternate double and single loops, or steel wire ring fasteners. In the case that additional adjacent bases are to be covered at one time, mesh rolls shall be used in place of unit size lids. Revet mattresses shall be uniformly overfilled by about one (1) inch to two (2) inches to compensate for future rock settlements.

205.3.2.4.3 Non-Rectangular Shapes: Gabion and mattress units can conform to bends up to a radius of curvature of 60 to 70 feet without alterations. Units shall be securely connected first, and be placed to the required curvature, holding them in position by staking the units to the ground with hardwood pegs before filling. For other shapes, bevels and miters can be easily formed by cutting and folding the panels to the required angles.

205.3.2.5 Closing: Lids shall be tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. Adjacent lids may be securely attached simultaneously. The panel edges shall be pulled to be connected using the appropriate closing tools where necessary. Single point leverage tools, such as crowbars, may damage the wire mesh and shall not be used. All end wires shall then be turned in.

205.3.3 NON-ENCLOSED RIP-RAP

205.3.3.1 Site Preparation: Area to receive fabric shall be cleared and graded as required within the contract documents. Contractor is to remove all large, sharp objects which include but are not limited to rocks, cut trees, shrubs, glass, etc., which may damage fabric. Contractor is to ensure that all areas to be covered are stable and compacted to that indicated on the Contract Drawings.

205.3.3.2 Fabric Placement: Fabric shall be placed in accordance with Section 206.

205.3.3.3 Wire Enclosed Rip-Rap Placement: Rip-Rap stones shall be placed to form a continuous blanket of the minimum thickness indicated on the Contract Drawings. Stones shall be placed with their long axis parallel to the toe of the slope and shall have a stable bearing upon the underlying soil or stones. Stone sizes are to be no less than four (4) inches in the shortest dimensions and are to be between 1/6 – 2/3 cubic feet by volume. The joints between larger stones shall be as close as practical and shall be filled with smaller slope. The Contractor shall use extreme care in placing stones on the geotextile fabric so not to tear or otherwise damage the fabric. The Contractor is to ensure that a layer of fabric is placed at the interface between the sloped and stone surfaces as shown on the Contract Drawings.

205.3.4 EROSION CONTROL BLANKETS AND REINFORCEMENT MATS

205.3.4.1 Site Preparation: Area to receive erosion control blankets and/or reinforcement mats to receive fabric shall be cleared and graded as required within the contract documents. Contractor is to remove all large, sharp objects which include but are not limited to rocks, cut trees, shrubs, glass, etc., which may damage blankets and mats. Contractor is to ensure that all areas to be covered are stable and compacted to that indicated on the Contract Drawings.

Before placing the erosion control blankets, ensure the subgrade has been graded smooth; has no depressed, void areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter. Verify that mesh does not include invasive species. Vehicles will not be permitted directly on the blankets.

205.3.4.2 Protecting Existing Vegetation: When there are established lawns in the work area, the turf must be covered and/or protected or replaced after construction operations. Identify existing trees, shrubs, plant beds, and landscape features that are to be preserved on site by appropriate tags and barricade with reusable, high-visibility fencing along the dripline. Mitigate damage to existing trees at no additional cost to the Owner.

205.3.4.3 Obstructions Below Ground: When obstructions below ground affect the work, submit shop drawings showing proposed adjustments to placement of erosion control material for approval

205.3.4.4 Finished Grade: Provide condition of finish grade status prior to installation, location of underground utilities and facilities. Verify that finished grades are as indicated on the drawings; complete finish grading and compaction in accordance with Section EARTHWORK, prior to the commencement of the work. Verify and mark the location of underground utilities and facilities in the area of the work. Repair damage to underground utilities and facilities at the Contractor's expense.

205.3.4.5 Placement: Immediately stabilize exposed soil using fabric, mulch, compost, and/or seed. Stabilize areas for construction access immediately as specified in the paragraph Construction Entrance. Install principal sediment basins and traps before any major site grading takes place. Provide additional sediment traps and sediment fences as grading progresses. Provide inlet and outlet protection at the ends of new drainage systems. Remove temporary erosion control measures at the end of construction and provide permanent seeding.

I. Install erosion control blankets as indicated and in accordance with manufacturer's recommendations. The extent of erosion control blankets must be as indicated.
II. Orient erosion control blankets in vertical strips and anchored with staples, as indicated. Abut adjacent strips to allow for installation of a common row of

staples. Overlap horizontal joints between erosion control blankets sufficiently to accommodate a common row of staples with the uphill end on top.

III. Where exposed to overland sheet flow, locate a trench at the uphill termination. Staple the erosion control blanket to the bottom of the trench. Backfill and compact the trench as required.

IV. Where terminating in a channel containing an installed blanket, the erosion control blanket must overlap installed blanket sufficiently to accommodate a common row of staples.

205.3.5 CLEAN UP

Dispose of excess material, debris, and waste materials offsite at an approved landfill or recycling center. Clear adjacent paved areas. Immediately upon completion of the installation in an area, protect the area against traffic or other use by erecting barricades and providing signage as required, or as directed.

205.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the specifications shall be as set forth in the Special Conditions.

206 GEOTEXTILE FABRIC AND GEOGRIDS - INDEX

206 GEOTEXTILE FABRIC AND GEOGRIDS

206.1 GENERAL

206.1.1 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 107, Storm Water Pollution Prevention
III. Section 108, Water Pollution Control
IV. Section 202, Clearing and Grubbing
V. Section 204, Fill Materials

206.1.2 SUBMITTALS

206.1.2.1 Product Data: Manufacturing Quality Control Sampling and Testing
A minimum of seven (7) days prior to scheduled use, manufacturer's quality control manual shall be submitted.

206.1.2.2 Certificates: A minimum of seven (7) days prior to scheduled use, submit manufacturer's Certificate of Compliance stating that the geotextile fabric and/or geogrids meet the requirements of this Section. The Certificate of Compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer and/or geogrid manufacturer. Items submitted shall also be approved by the Engineer prior to use.

206.1.3 DELIVERY, STORAGE, AND HANDLING

Delivery, storage, and handling of geotextile and geogrids shall be in accordance with the manufacturer’s literature.

206.1.3.1 Delivery: The Engineer shall be notified a minimum of 24 hours prior to delivery and unloading of geotextile rolls or geogrids, and the Contractor shall verify the intended product was received.

Geotextile rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until ready for use. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

Geogrid rolls shall be delivered to the jobsite in roll form with each roll individually identified and with the correct nominal measurements of width and length as noted in the manufacturer’s specifications.

206.1.3.2 Storage: Rolls of geotextiles and/or geogrids shall be protected from construction equipment, chemicals, sparks and flames, temperatures more than 160 degrees Fahrenheit, or any other environmental conditions that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

Store rolls in a manner that prevents excessive mud, wet concrete, epoxy or other deleterious materials from coming in contact with and affixing to the geogrid. Store geogrids above –20 degrees Fahrenheit. Rolls may be stored vertically (rolls stood on end) or, typically, horizontally in stacks not exceeding five (5) rolls high.

206.1.3.3 Handling: Geotextile and geogrid rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

Avoid handling rolls below 14 degrees Fahrenheit.

206.2 MATERIALS

206.2.1 GEOTEXTILES

Geotextile shall be a nonwoven pervious sheet of polymeric material and shall consist of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. Stabilizers and/or inhibitors shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Geotextiles shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction.

TABLE 1: MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

Property	**Required Min. Value**	**Test Method**
Tensile Strength, lbs.	200.0	ASTM D4632
Weight, oz./ yd2,	8.0	ASTM D3776
Puncture Strength, lbs.	75.0	ASTM D4833
Trapezoid Tear, lbs.	75.0	ASTM D4533
Apparent Opening Size units	70.0	ASTM D4751
Permittivity, gal/min/sf	30.0	ASTM D4491
Ultraviolet Degradation Retained Strength @ 150 hrs., %	70.0	ASTM D4355

206.2.2 GEOGRIDS

Geogrids used as ground stabilizing solutions shall be manufactured from punched polypropylene sheets oriented in multiple, equilateral directions to form triangular apertures. The geogrids shall have a high radial stiffness throughout a full 360 degrees to create an in-service stress transfer from the aggregate to the stabilizing geogrid. Contractor shall use Tensar® TriAx® (TX) Geogrids called for in the project documents and/or described in the table below. An approved or equal can be submitted by the Contactor for use, if applicable, in accordance with Paragraph 206.1.2.

TABLE 2a: MINIMUM PHYSICAL REQUIREMENTS FOR GEOGRID: TX 130S GEOGRID

Property	Required Value	Test Method
Rib Pitch (Longitudinal)	1.3 inches	ASTM D4759
Rib Pitch (Diagonal)	1.3 inches	ASTM D4759
Rib Shape	Rectangular	-
Aperture Shape	Triangular	-
Junction Efficiency	93%	ASTM D6637 ASTM D7737
Isotropic Stiffness Ratio	0.6	-
Radial Stiffness at 0.5% Strain	13,708 lb/ft	ASTM D6637
Resistance to Chemical Degradation	100%	EPA 9090
Resistance to Ultra-Violet Light and Weathering	70%	ASTM D4355

TABLE 2b: MINIMUM PHYSICAL REQUIREMENTS FOR GEOGRID: T X 140 GEOGRID

Property	Required Value	Test Method
Rib Pitch (Longitudinal)	1.6 inches	ASTM D4759
Rib Pitch (Diagonal)	1.6 inches	ASTM D4759
Mid-Rib Depth (Diagonal)	0.5 inch	ASTM D4759
Mid-Rib Depth (Transverse)	0.5 inch	ASTM D4759
Mid-Rib Width (Diagonal)	0.4 inch	ASTM D4759
Mid-Rib Width (Transverse)	0.4 inch	ASTM D4759
Rib Shape	Rectangular	-
Aperture Shape	Triangular	-
Junction Efficiency	93%	ASTM D6637 ASTM D7737
Radial Stiffness at 0.5% Strain	15,430 lb./ft	ASTM D663
Resistance to Chemical Degradation	100%	EPA 9090
Resistance to Ultra-Violet Light and Weathering	70%	ASTM D4355

206.3 EXECUTION

206.3.1 INSTALLATION OF GEOTEXTILE FABRIC

Installation of geotextiles shall be in accordance the manufacturer's literature.

206.3.1.1 Subgrade Preparation: Contractor shall remove all vegetation in accordance with Section 202. Contractor shall then scarify eight (8) inches down and recompact existing soil to 95 percent Standard Proctor unless otherwise called for in project documents. The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Fabric placement shall start at the bottom of the slope, or lowest elevation, and work up the slope.

206.3.1.2 Placement: The Contractor shall notify the Engineer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 1 vertical to 10 horizontal and in trenches, the geotextile shall be laid with the machine direction of the fabric parallel to the slope direction.

206.3.1.3 Seams: Geotextile panels shall be continuously overlapped a minimum of 12 inches at all longitudinal and transverse joints. Where seams must be oriented across the slope or in trenches, the upper panel shall be lapped over the lower panel.

206.3.1.4 Protection: The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.

206.3.1.5 Repairs: Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. Geotextile rolls which cannot be repaired shall be removed and replaced.

206.3.1.6 Penetrations: Engineered penetrations of the geotextile shall be constructed by methods recommended by the geotextile manufacturer.

206.3.1.7 Covering: Geotextile shall not be covered prior to inspection and approval by the Engineer. Cover aggregate shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On sloped surfaces, aggregate backfill shall be placed from the bottom of the slope upward. Cover gravel

shall not be dropped onto the geotextile from a height greater than three (3) feet. No equipment shall be operated directly on top of the geotextile without approval of the Engineer. Equipment with ground pressures less than seven (7) pounds per square inch (psi) shall be used to place the first lift over the geotextile. Cover aggregate, compaction, and testing requirements as specified in contract documents. Equipment placing cover aggregate shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding two (2) miles per hour (mph).

206.3.2 INSTALLATION OF GEOGRIDS

Install geogrids in accordance with geogrid manufacture's recommendations. General installation procedures are explained below, but are superseded by manufacturer's recommendations unless otherwise determined by the Engineer. Refer to the manufacturer's recommendations for special considerations.

206.3.2.1 Subgrade Preparation: Contractor shall refer to the manufacture's recommendations on subgrade preparation to determine if special precautions shall be taken due to soil strength of the project site. All vegetation removal shall be in accordance with Section 202. Excavate (if necessary) to the design subgrade elevation, stripping topsoil, debris and unsuitable material from the site. Smooth grade and compact the soils using appropriate compaction equipment. Grade or crown the surface for positive drainage away from the construction zone.

206.3.2.2 Placement: The Contractor shall notify the Engineer a minimum of 24 hours prior to installation of geogrids. Geogrid rolls which are damaged or contain imperfections shall be repaired or replaced as directed. Unroll the geogrid and overlap adjacent rills along their sides and ends in the direction(s) specified by the manufacturer.

206.3.2.3 Seams: Overlap geogrids in the direction the fill placement will be spread to avoid peeling of geogrid at overlaps by the advancing fill. Mechanically fastening adjacent geogrids to one another is not required unless the need is determined following an examination of the subgrade and manufacturer's literature. Mechanical fasteners can help maintain overlap dimensions. Cut and overlap the geogrid to accommodate curves and to conform to manhole covers and other immovable protrusions. Place geogrids in daily work sections so that proper alignment is maintained. The installer shall take appropriate measures to ensure that the product lies flat during fill placement.

206.3.2.4 Tensioning and Pinning: Geogrids may be anchored in place to maintain overlaps and alignment over the coverage area. Before fully unrolling the geogrid, anchor the beginning of the roll, in the center and at the corners, to the underlying surface. After unrolling the Geogrid fully, align it and pull it taught to remove wrinkles and laydown slack with hand tension, then secure in place. Additional actions may be required to hold the geogrid in place prior to placement of the aggregate fill.

206.3.2.5 Covering: Geogrids shall not be covered prior to inspection and approval by the Engineer. See manufacturer's instructions for initial lift thickness of aggregate needed to fill over geogrids. Aggregate fill may be dumped directly onto the geogrid if competent subgrades lie underneath. On sloped surfaces, aggregate backfill shall be placed from the bottom of the slope upward. Cover gravel shall not be dropped onto the geotextile from a height greater than three (3) feet. The desired effect is fill that cascades onto the geogrid, rather than being pushed into it. For most subgrades, standard, highway-legal, rubber- tired trucks may drive over the geogrid at very slow speeds (less than five (5) mph) and dump aggregate fill as they advance, provided this construction traffic will not cause significant rutting upon bare subgrade. Turns and sudden starts and stops should be avoided. The Contractor shall refer to manufacturer's literature and recommendations for how to proceed when dealing with softer subgrades.

Do not drive tracked equipment directly on the geogrid product and ensure required minimum design or at least six (6) inches of aggregate fill is spread between the geogrid and tracked equipment. Also, only operate rubber-tired equipment directly on the geogrid if the underlying subsoil is not prone to rutting under limited construction traffic. Refer to manufacture's recommendations for instructions on how to proceed over softer subgrades.

206.3.2.6 Compacting: Standard compaction methods may be used unless the soils are very soft. Reference the manufacturer's literature and recommendations prior to each compacting event to ensure standard compaction methods are appropriate and that aggregate fill thickness is sufficient to support imposed load when constructing over certain materials. Measures should be taken to ensure the proper thickness of granular fill is placed atop the geogrid to maximize support and minimize movement at the surface.

Compact aggregate fill to project specifications, after it has been graded smooth and before it is subject to accumulated traffic. Inadequate compaction will result in surface rutting under wheel loads. This rutting reduces the total effective thickness of the fill and increases stress on the subgrade. Compaction equipment and methods should be appropriate for the type of fill being used, its thickness and the underlying subgrade conditions. In the case of rutting or severe pumping under truck or dozer traffic, immediately reference the manufacturer's recommendations to determine the best way to mediate the issue.

206.4 MEASUREMENT AND PAYMENT

Measurement and payment for the work covered by this section of the specifications shall be considered incidental to the items of work described in the Special Conditions.

301 CAST-IN-PLACE CONCRETE – INDEX

301 CAST-IN-PLACE CONCRETE

301.1 GENERAL

301.1.1 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 201, General Earthwork
III. Section 204, Fill Materials
IV. Section 302, Concrete Formwork

301.1.2 DEFINTIONS

301.1.2.1 Cementitious Material: Used herein shall include all Portland cement, pozzolan, and fly ash.

301.1.2.2 Exposed to Public View: Means situated so that it can be seen from eye level from a public location after completion. A public location is accessible to persons not responsible for operation or maintenance.

301.1.2.3 Deformed Reinforcing Steel: Reinforcing steel to conform to provisions of ASTM A615, Grades 40 or 60 as designated in the project drawings.

301.1.3 SUBMITTALS

The following shall be submitted in accordance with Section 101.

301.1.3.1 Certifications: Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

301.1.3.2 Shop Drawings:

I. Formwork, Reinforcing Steel
    i. Reproductions of contract drawings are unacceptable

301.1.3.3 Product Data:

I. Sources of cement, fly ash and aggregates
II. Material safety data sheets (MSDS) for all concrete components and admixtures.
III. Air Entrainment Admixture. Product data including catalogue cuts, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.

IV. High range water reducing admixture (plasticizer). Product data including catalogue cuts, technical data, storage requirements, product lift, recommended dosage, temperature considerations, retarding effects, slump range, and conformity to ASTM standards. Identify proposed location of use.

V. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio versus cylinder strength for each formulation of concrete proposed based on laboratory tests. The cylinder strength shall be the average of the 28 day cylinder strength test result for each mix. Provide results of seven (7) and 14 day tests if available.

VI. Sheet curing material. Product data including catalogue cuts, technical data.

VII. Liquid curing compound. Product data including catalogue cuts, technical data, storage requirements, product life, application rate.

301.1.3.4 Design Data: Concrete mix design shall be submitted thirty days minimum prior to concrete placement. Submit a complete list of materials including type, brand, source, and amount of cement, fly ash, pozzolans, polypropylene fibers, and admixtures. If source material changes, the Contractor shall resubmit mix proportion data using revised source material. Submit additional data regarding concrete aggregates if the source of aggregate changes. In addition, copies of the fly ash, polypropylene fibers, and pozzolan test results shall be submitted.

301.1.3.5 Test Reports: The following test reports shall be less than twelve months old.

I. Fine Aggregates - sieve analysis, physical properties, ASR resistance and deleterious substances

II. Coarse aggregates - sieve analysis, physical properties, ASR resistance and deleterious substances

III. Cements - chemical analysis and physical properties

IV. Fly Ash - chemical analysis and physical properties

V. Proposed Concrete Mixes - compressive strength, slump, air content, admixtures, material sources, physical properties, and mixture proportions. Field test data meeting ACI 301.4.2.3.2.a or compressive strength test results on three (3), six (6) inch cylinders, at seven (7) days; and 28 days shall be provided.

301.1.3.5.1 Concrete Mix Design: The Contractor shall submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified here in and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other tests for cement, aggregates, and admixtures. The Contractor shall provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Test reports shall be submitted along with the concrete mix design.

301.1.3.5.2 Fly Ash and Pozzolan: The Contractor shall submit test results in accordance with ASTM C 618 for fly ash and pozzolan.

301.2 MATERIALS

301.2.1 MATERIALS FOR FORMS

Materials for forms shall conform to Section 302.

301.2.2 FORM TIES AND ACCESSORIES

Form ties and accessories shall conform to Section 302.

301.2.3 CEMENT

Cement shall conform to ASTM C 150, Type I or II. The cement shall consist of a mixture of ASTM C 150, Type I or II, cement and one of the following materials: ASTM C 618 pozzolan or fly ash. The pozzolan or fly ash content shall not exceed 25 percent by weight of the total cementitious material. For exposed concrete, use one manufacturer for each type of cement, fly ash, and pozzolan.

301.2.3.1 Fly Ash and Pozzolan: Shall conform to ASTM C 618, Type F, or C. The maximum allowable loss on ignition shall be three (3) percent.

301.2.4 CONCRETE

301.2.4.1 Concrete Mix: Concrete mix shall produce a compressive strength, f'c, of a minimum 4000 pounds per square inch (psi) at 28 days with 4.5 percent - 7.5 percent entrained air. The maximum allowable slump shall not be in excess of four (4) inches, and/or the water cement ratio shall not exceed 0.45. The strength of the concrete will be considered satisfactory so long as the average of all sets of the three (3) consecutive test results equals or exceeds the specified compressive strength, f'c, and no individual test result falls below the specified strength, f'c, by more than 500 PSI. Correction of the replacement of deficient concrete will be done at the Contractor's expense.

301.2.4.1.1 Mix Proportions for Normal Weight Concrete: Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C192/C192M-16a and tested in accordance with ASTM C 39. Samples of all materials used in mixture, proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Laboratory trial mixture shall be designed for maximum permitted slump and air content. Each combination of material proposed for use shall have separate trial mixture. Accelerator or retarder use can be provided without separate trial mixture. The temperature of concrete in each trial batch shall be reported.

301.2.4.1.2 Required Average Strength of Mix Design: The selected mixture shall produce an average compressive strength exceeding the specified strength by the

amount indicated in ACI 214. When a concrete production facility has a record of at least 15 consecutive tests the standard deviation shall be calculated and the required average compressive strength shall be determined in accordance with ACI 214. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength for mix designs between 3000 and 5000 psi shall be 1200 psi plus f'c.

301.2.5 WATER

Water shall be fresh, clean, potable, and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete. Water shall meet ASTM C1602/C1602M-12, including Table 2, from a municipal or other approved source.

301.2.6 AIR-ENTRAINED ADMIXTURE FOR CONCRETE

Concrete shall conform to the requirements of AASHTO M154.

301.2.7 CHEMICAL ADMIXTURE

Shall conform to the requirements of AASHTO M194 or ASTM C 494/C 494M:

I. Type A: Water-reducing admixtures
II. Type B: Retarding mixtures
III. Type C: Accelerating mixtures
IV. Type D: Water-reducing & retarding admixtures
V. Type E: Water-reducing & accelerating admixtures
VI. Type F: Water-reducing, high-range admixtures

Do not use calcium chloride admixtures.

301.2.7.1 High Range Water Reducer (HRWR) (Superplasticizers): Reference Type F and ASTM C 1017/C1017M.

301.2.8 MATERIALS FOR CURING CONCRETE

301.2.8.1 Impervious Sheeting: Waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap shall meet the requirements of AASHTO M171 or ASTM C 171. Only white reflective type shall be permitted.

301.2.8.2 Pervious Sheeting and Burlap: Pervious Sheeting and burlap shall conform to AASHTO M182.

301.2.8.3 Liquid Membrane-Forming Compound: Compound shall be Type 1 or Type 2, Class B. Reference AASHTO M148 or ASTM C 309 for standard specifications for Liquid Membrane-Forming Compound.

301.2.9 EXPANSION/CONTRACTION JOINT FILLER

Filler shall conform to ASTM D1751, ASTM D1752, or 100 percent recycled material meeting ASTM D1752. Material shall be 1/2 inch thick, unless otherwise indicated.

301.2.10 JOINT SEALANTS

301.2.10.1 Horizontal Surfaces: Horizontal three (3) percent slope, Maximum ASTM D 1190 or ASTM C 920, Type M, Class 25.

301.2.10.2 Vertical Surfaces Greater Than 3 Percent Slope: ASTM C 920, Type M, Grade NS, Class 25.

301.2.11 BIODEGREADABLE FORM RELEASE AGENT

Form release agent shall be biodegradable with a maximum of 350 grams/liter volatile organic compounds (VOCs). Product shall not bond with, stain, or adversely affect concrete surfaces and shall not impair subsequent treatments of concrete surfaces. The form release agent shall not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

301.2.12 AGGREGATES

The following items are required for concrete aggregate:

I. Assure aggregates are not deleteriously alkali-silica reactive (ASR).

II. Test for potential of deleterious alkali-silica reaction of coarse and fine aggregate shall be conducted in accordance with ASTM C1260.

i. If expansion at 16 days does not exceed 0.10 percent then the coarse or fine aggregates will be acceptable.
ii. If expansion at 16 days is greater than 0.10 percent, but less than 0.20 percent, aggregates are acceptable if petro-graphic examination shows the expansion is not due to ASR.

A. Otherwise, test specimens according to ASTM C 1567 using all components (e.g. coarse aggregate, fine aggregate, cementious materials, and/or specific reactivity reducing chemicals) in the proportions proposed for the mixture design and retest.
B. For mixtures using lithium admixtures use test procedure CRD-C662.
C. Expansion of the proposed mixture design test specimens, tested in accordance with ASTM C1567, shall not exceed 0.10 percent after 16 days from casting.
D. If the expansion of the proposed mixture design test specimens is greater than 0.10 percent after 16 days, the aggregates will not be acceptable unless adjustments to the mixture design can reduce the expansion to less than 0.10 percent after 16 days, or new aggregates shall be evaluated and tested, or testing by ASTM C1293 indicates the aggregates will not experience deleterious expansion.

iii. If expansion at 16 days is greater than 0.20 percent, the aggregate will not be acceptable unless a combination of cement, aggregate, and supplemental cementitious materials is found to effectively mitigate the expansion using ASTM C1567.
iv. Substitution of ASTM C1293 test results for ASTM C1260 test results is acceptable, however, the average concrete prism expansion shall be less than 0.04 percent at one (1) year.
v. ASTM C33, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source.

301.2.13 FINE AGGREGATE

Shall consist of natural sand or other inert materials with similar characteristics conforming to Table 1:

TABLE 1

Sieve Size	Percent Passing
3/8	100
No. 4	90-100
No. 16	45-80
No. 50	5-30
No. 100	0-8
No. 200	0-3

301.2.14 COARSE AGGREGATE

Shall consist of crushed stone, crushed gravel or natural washed gravel conforming to Table 2:

TABLE 2

Sieve Size	Percent Passing
1 ½ inches	100
1 inch	95-100
½ inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-1

301.2.15 FLY ASH

Class C fly ash shall not be utilized. Class F fly ash should be required in the range of 15 percent – 25 percent replacement of the total cementitious material by weight. The Environmental Protection Agency (EPA) requires that all federally funded projects use at least 15 percent recovered materials such as fly ash.

301.2.15.1 ASTM C 618, Class F, except:

I. Sulfur trioxide; maximum of 4.0 percent.
II. Calcium oxide; maximum of 8.0 percent.
III. Loss on ignition; maximum of 3.0 percent.
IV. Test for effectiveness in controlling alkali-silica reaction under supplementary optional physical requirements in Table 3 of ASTM C 618. Use low-alkali cement for test.
V. Does not decrease sulfate resistance of concrete by use of pozzolan.
    i. Demonstrate pozzolan will have an "R" factor less than 2.5.
    ii. R = (C-5)/F.
    iii. C: Calcium oxide content of pozzolan, in percent, determined in accordance with ASTM C 114.
    iv. F: Ferric oxide content of pozzolan, in percent, determined in accordance with ASTM C 114.

301.2.16 REINFORCEMENT

301.2.16.1 Reinforcing Bars: ASTM A 615/A 615M and ASTM A 617/A 617M with the bars marked A, S, W, Grade 40 or 60.

301.2.16.2 Welded Wire Fabric: ASTM A 185 or ASTM A 497. Provide flat sheets of welded wire fabric for slabs and toppings.

301.2.16.3 Wire: ASTM A 82 or ASTM A 496 standards.

301.2.16.4 Reinforcing Bar Supports: Provide bar ties and supports of coated or non-corrodible material.

301.3 EXECUTION

301.3.1 FORMWORK INSTALLATION

Formwork installation shall comply to all of Section 302.

301.3.2 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement shall not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

301.3.2.1 Reinforcement Supports: Place reinforcement and secure with galvanized or non-corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non-corrodible material having a compressive strength equal to or greater than the concrete to be poured.

301.3.2.2 Splicing: Splice reinforcing steel as indicated. Splices shall be a minimum of 40 bar diameters in length unless otherwise indicated. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires plus two (2) inches.

301.3.2.3 Cover: Minimum coverage shall be three (3) inches, or as indicated.

301.3.2.4 Setting Miscellaneous Material: Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

301.3.2.5 Construction Joints: Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

301.3.2.6 Expansion Joints and Contraction Joints: Expansion and contraction joints shall be in accordance with the details shown or as otherwise specified. Provide expansion joint at edges of slabs on grade abutting vertical surfaces and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Sawed joints shall be completed within four (4) to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

303.3.3 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

Batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances: One (1) percent for cement and water, two (2) percent for aggregate, and three (3) percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

303.3.3.1 Mixing: Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 85 degrees Fahrenheit. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 85 degrees Fahrenheit. If set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional

water is added an additional 30 revolutions of the mixer at mixing speed is required. If the entrained air content falls below the specified limit add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

303.3.3.2 Transporting: Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Remove concrete which has segregated in transporting and dispose of as directed.

301.3.4 CONCRETE PLACEMENT

The measuring, mixing, manufacture, transporting, and placing of concrete shall comply with ACI 304 and ASTM C94 and as specified. All concrete shall be placed in the presence of the Engineer. Aluminum pipe and chutes shall not be used in concrete placement.

Water shall only be added to batched concrete on site if the water to cement ratio of the mix design is not exceeded and the addition is approved by the Engineer. Additional water shall be added before the concrete is discharged from the truck. Concrete shall be mixed for a minimum of 20 revolutions of the mixer drum at mixing speed before concrete is discharged. Additional water shall be recorded on batch ticket to the nearest gallon. No water shall be added to the concrete after discharge to aid in the finishing of concrete. Concrete that has become so stiff it cannot be placed or finished shall not be used.

The Contractor will only be allowed to add air entraining admixtures to the batched concrete once at the site, and as approved by the Engineer. After the admixture is added, the concrete shall be re-mixed for a minimum of 20 revolutions of the mixer drum, at mixing speed. Contractor quality testing and the Owner's quality assurance tests will be taken after the addition and additional revolutions. Additional air entraining admixture should be recorded on the batch ticket to the nearest ounce.

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Concrete placement shall not be permitted when weather conditions (precipitation, wind, temperature, and standing or flowing water) prevent proper placement and consolidation of concrete. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. The concrete shall be delivered to the site of the work and discharge shall be completed within 1 1/2 hours when temperatures are less than 90 degrees Fahrenheit. Discharge shall be completed in one (1) hour when temperatures are above 90 degrees Fahrenheit. Concrete shall be placed from the mixer to the forms as rapidly as practicable by methods which prevent segregation or loss of ingredients. Concrete shall be in place and consolidated within 15 minutes after discharge from the mixer. Concrete shall be deposited as close as possible to its final position in the forms and be so regulated that it may be effectively consolidated in horizontal layers 18 inches or less in thickness with a minimum of lateral movement. Do not exceed a free vertical drop of three (3) feet from the point of

discharge. The placement shall be carried on at such a rate that the formation of cold joints will be prevented. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 20-foot centers maximum for exterior slabs.

301.3.4.1 Footing Placement: Concrete for footings may be placed in excavations without forms upon inspection and approval by the Engineer. Excavation width shall be a minimum of four (4) inches greater than indicated.

301.3.4.2 Consolidation: Each layer of concrete shall be consolidated by internal vibrating equipment. External vibrators shall be used on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete. Consolidate concrete slabs greater than four (4) inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs four (4) inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. The Contractor shall furnish a spare, working, vibrator on the job site whenever concrete is placed.

301.3.4.2.1 Internal vibration: Internal vibration shall be systematically accomplished by inserting the vibrator through fresh concrete in the layer below at a uniform spacing over the entire area of placement. The distance between insertions shall roughly be the smaller of 18 inches apart or 1.5 times the radius of action of the vibrator less two (2) inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least six (6) inches into the layer below, if such a layer exists. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. It should be held stationary until the concrete is consolidated and then withdrawn slowly at a rate of approximately three (3) inches per second. Penetrate the previously placed lift with the vibrator when more than one (1) lift is required. Place concrete in 18-inch maximum vertical lifts. Do not use vibrators to transport the concrete in the forms.

301.3.4.3 Pumping: Pumping shall not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment shall not exceed two (2) inches. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy. Rapid changes in pipe sizes shall be avoided. Maximum size of course aggregate shall be limited to 33 percent of the diameter of the pipe. Maximum size of well-rounded aggregate shall be limited to 40 percent of the pipe diameter. Samples for testing shall be taken at both the point of delivery to the pump and at the discharge end.

301.3.4.4 Cold Weather Requirements: No concrete placement shall be made when the ambient temperature is below 35 degrees Fahrenheit or if the ambient temperature is below 40 degrees Fahrenheit and falling. Placement may begin when the air temperature reaches 35 degrees Fahrenheit and is rising or is already above 40 degrees Fahrenheit. Provisions shall be made to protect concrete from freezing during the specified curing period. If it is necessary to place concrete when the temperature of the air, aggregates, or

water is below 35 degrees Fahrenheit, placement and protection shall be approved in writing by the Engineer. Suitable covering and other means, as approved, shall be provided for maintaining the concrete at a temperature of at least 50 degrees Fahrenheit minimum adjacent to both the formwork and the structure for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Limit the rate of cooling to five (5) degrees Fahrenheit in any one (1) hour, and 50 degrees Fahrenheit per 24 hours after heat application. Cold weather concrete shall be placed in accordance with ACI 306R as appropriate. Any concrete damaged by freezing shall be removed and replaced at the expense of the Contractor.

301.3.4.5 Hot Weather Placement: Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable, material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. When the rate of evaporation of surface moisture, as determined by use of Figure 1 of ACI 308R, is expected to exceed 0.2 pounds per square foot per hour, provisions for windbreak, shading, fog spraying, or covering with a light-colored material shall be made in advance of placement and such protective measures shall be taken as quickly as finishing operations will allow. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set. Contractor to pour and finish slabs in the cool morning hours to the extent possible in hot weather. Hot weather concrete to be placed in accordance with ACI 305R as appropriate.

301.3.5 FINISHES

No finishing or repair will be done when either the concrete or the ambient temperature is below 40 degrees Fahrenheit.

301.3.5.1 Finishing Formed Surfaces: All fine and loose materials shall be removed and surface defects including tie holes shall be filled. All “honeycomb” areas and other defects shall be repaired. All unsound concrete shall be removed from areas to be repaired. Surface defects greater than 1/2 inch in diameter holes left by removal of tie rods, and other surfaces not to receive additional concrete shall be reamed or chipped and filled with dry-pack mortar. The prepared area shall be brush-coated with an approved epoxy, resin, or latex bonding compound or with a neat cement grout after dampening and filling with mortar or concrete. The cement used in mortar or concrete for repairs to all surfaces permanently exposed to view shall be a blend of Portland Cement and white cement so that the final color when cured will be the same as the adjacent concrete.

301.3.5.1.1 Rubbed Surface: Provide a "rubbed" surface finish when called for in the project documents. Surface shall be rubbed with an abrasive stone and a watery grout mixture to produce a sand like finish. The finished surface is to be etched into the concrete face rather than a plastered layer.

301.3.5.2 Finishing Slab Surfaces: All slab surfaces not to be covered by additional concrete or backfill shall be float finished to elevations shown. Surfaces shall be sloped for drainage unless otherwise shown. Joints shall be carefully made using a jointing tool of minimum 3/4-inch depth. Edges to be rounded with a small radius tool. Slab surfaces shall be finished to a tolerance of 1/8-inch for a float finish as determined by a 10 foot straight edge placed on surfaces shown on the plans to be level or having a constant slope. No water or cement shall be added to the surface during finishing.

301.3.5.2.1 Float Finish: Surfaces to be float finished shall be screeded or hand floated and bull floated to eliminate the ridges and to fill in the voids left by the screed. In addition, the bull float shall fill all surface voids and only slightly embed the coarse aggregate below the surface of the fresh concrete. Floating should remove slight imperfections, humps, and voids to produce a plane surface.

301.3.5.2.2 Broom Finish: A broom finish shall be applied to all exterior flat work. Flat work is to be finished as mentioned above, and trowled with a steel tool. After surface moisture disappears, the surface shall be brushed or broomed with a broom or fiber bristle brush in a direction transverse to that of foot or vehicular traffic.

301.3.5.2.3 Smooth Troweled Finish: Interior building slabs shall have a smooth troweled finish unless otherwise noted.

301.3.6 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

301.3.6.1 Defects: Repair formed surfaces by removing minor "honeycombs", pits greater than 1 square inch surface area or 1/4 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with non-shrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive "honeycomb", including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength, will be rejected unless correction of defects is approved. Obtain approval of corrective action prior to repair from the Engineer. The surface of the concrete shall not vary more than the allowable tolerances as specified. Exposed surfaces shall be uniform in appearance and finished to a smooth form finish unless otherwise specified.

301.3.6.2 Not Against Forms (Top of Walls): Surfaces not otherwise specified shall be finished with wood floats to even surfaces. Finish shall match adjacent finishes.

301.3.6.3 Formed Surfaces:

301.3.6.3.1 Tolerances: Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10 foot straight edge.

301.3.6.3.2 As-Cast Rough Form: Provide for surfaces not exposed to public view. Patch holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 1/4 inch in height.

301.3.7 CURING AND PROTECTION

Beginning immediately after placement and continuing for seven (7) days, all concrete shall be cured and protected from the elements such as; sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. All materials required for adequate curing and protection shall be present on site at the location of concrete placement prior to the start of the placement. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Preservation of moisture within concrete not in contact with the forms shall be accomplished by the application of membrane forming compound conforming to these specifications or by covering with plastic. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period.

301.3.7.1 Moist Curing:

301.3.7.1.1 Ponding or Immersion: Continually immerse the concrete throughout the curing period. Water shall not be more than 20 degrees Fahrenheit less than the temperature of the concrete. For temperatures between 40 and 50 degrees Fahrenheit, increase the curing period by 50 percent.

301.3.7.1.2 Fog Spraying or Sprinkling: Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees Fahrenheit, increase the curing period by 50 percent.

301.3.7.1.3 Pervious Sheeting: Completely cover surface and edges of the concrete with two (2) thicknesses of wet sheeting. Overlap sheeting six (6) inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

301.3.7.1.4 Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting no less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting, overlap and continuously tape sheeting joints, and introduce sufficient water to soak the entire surface prior to completely enclosing.

301.3.7.2 Liquid Membrane-Forming Curing Compound: Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period.

301.3.7.2.1 Application: Otherwise recommended by the manufacturer, apply compound immediately after the surface loses its water sheen and has a dull appearance and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats shall be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within three (3) hours after the curing compound application.

301.3.7.2.2 Protection of Treated Surfaces: Prohibit pedestrian, vehicular traffic, and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

301.3.7.3 Curing Periods: Protect concrete from premature drying, excessively hot temperatures, and mechanical injury. Maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval by the Engineer.

301.3.7.4 Requirements for Type III, High-Early-Strength Portland Cement: The curing periods shall be not less than one-fourth of those specified for Portland Cement, but in no case less than 72 hours.

301.3.8 CONCRETE REINFORCING STEEL

301.3.8.1 Reinforcing Steel Placement: Steel placement to conform to NM SSHBC (07) 540.3.1.4.1 and 540.3.1.4.2.

301.3.8.2 Reinforcing Steel Cover: Steel cover to conform to ACI 318-08 7.7.

301.3.8.3 Reinforcing Bar Bending: Bar bending to conform to NM SSHBC (07) Table 540.3.1.2:1.

301.3.8.4 Reinforcing Bar Cleaning: Cleaning of reinforcing bars to conform to NM SSHBC (07) Section 540.3.1.5.

301.3.8.5 Reinforcing Bar Storage: Bars shall not be stored on the ground – NM SSHBC (07) 540.3.1.

301.3.8.6 Bundling and Tagging: Tag and mark reinforcing bars in accordance with CSRI's Code of Standard Practice.

301.3.9 FIELD QUALITY CONTROL

301.3.9.1 General Requirements: The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing.

Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below and any additional tests to ensure the requirements of these specifications are met.

301.3.9.2 Sampling: Collect samples of fresh concrete to perform tests specified. ASTM C 31/C 31M for making test specimens.

301.3.9.3 Concrete Testing:

301.3.9.3.1 Strength Testing: The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken at a frequency no less than once a day nor less than once for every 50 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C172. Cylinders for acceptance shall be molded in conformance with ASTM C31/C31M by an approved testing laboratory. Each strength test result shall be the average of two (2) test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved by the Engineer. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three (3) consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the specified strength by more than 500

psi. Concrete represented by core test shall be considered structurally adequate if the average of three (3) cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c.

301.3.9.3.2 Air Content: Air content shall be determined in accordance with ASTM C173 or ASTM C231. ASTM C231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two (2) tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman. If results are out of tolerance the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until the air content is within the tolerance specified. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

301.3.9.3.3 Slump Test: Two (2) slump tests shall be made on randomly selected batches of each class of concrete for every 50 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

301.3.9.3.4 Temperature Tests: Test the concrete delivered and the concrete in the forms. Perform tests in cold weather conditions below 50 degrees Fahrenheit and in hot weather conditions above 80 degrees Fahrenheit for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

301.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the specifications shall be as set forth in the Special Conditions.

302 CONCRETE FORMWORK - INDEX

302 CONCRETE FORMWORK

302.1 GENERAL

302.1.1 CERTIFICATION

I. Manufacturer's data including literature describing form materials, accessories, and form releasing agent.
II. Manufacturer's recommendation on method and rate of application of form release agents.
III. Certification for the design of the formwork
IV. Design analysis and calculations for form design and methodology used in design.
V. Sequence of concrete placement. Indicate locations of form joints, panel sizes and patterns.

Review of the sequence of concrete placement, form system and panel layout shall be for appearance and strength of the completed structure only. Approval of forming plans or procedures shall not relieve the Contractor of responsibility for the strength, safety or correctness of methods used, the adequacy of equipment, or from carrying out the work in full compliance with the requirements of the drawings and as specified herein.

302.2 MATERIALS

302.2.1 FORMS

Forms for cast-in-place concrete shall be made of wood, plywood, steel, or other approved materials. Use plywood or steel forms where a smooth form finish is required. Wood forms for the project shall be nearly new. Wood forms shall be constructed utilizing sound lumber and plywood of suitable dimensions and free of raised grain, knotholes, and loose knots. Where used for exposed surfaces, dress and match boards and fit adjacent panels with tight joints. Plywood: PS1, B-B concrete form panels or better or AHA A135.4 hardboard shall be used for smooth form lining. Steel form surfaces shall not contain irregularities, dents, or sags. Metal forms may be used if approved by the Engineer and shall be appropriate type and class. All forms shall be designed and constructed to provide a flat, uniform concrete surface with minimal finishing and/or repair.

302.2.1.1 Wall Forms: Forms for all concrete walls shall be in good condition. Exterior grade plywood panels shall be manufactured in compliance with the APA and the trademark of that group, or equal as approved by the Engineer. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform, concrete surface requiring minimal finishing and grinding. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that under pressure the joint will remain watertight, will not bulge outward or create surface patterns.

302.2.1.2 Form Release Agent: Coat all forming surfaces in contact with concrete using an effective, non-shrinking, non-residual, water based, and bond breaking form coating unless otherwise noted in the project documents.

302.2.1.3 Form Ties and Accessories: Form ties encased in concrete shall have no metal within 1 1/2 inch of the face of the concrete after eyelet has been removed. The part of the tie to be removed shall be at least 1/2 inch in diameter and be provided with a plastic cone at least 1/2 inch in diameter and 1 1/2 inches long. The use of wire alone is prohibited. Form ties and accessories shall not reduce the effective cover of the reinforcement.

302.3 EXECUTION

302.3.1 FORMWORK INSTALLATION

Provide forms, shoring, and scaffolding for concrete placement. Forms shall be properly aligned, adequately supported, and mortar tight. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be the shape, lines, dimensions and appearance as shown on the drawings. Forms for walls shall have removable panels at the bottom for cleaning. Tremies and hoppers for placing concrete shall be used to prevent segregation and accumulation of hardened concrete on forms and reinforcing steel above fresh concrete. The form surface shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed faces. Chamfer all above grade exposed joints, edges, and external corners 3/4 inch unless otherwise indicated. Forms are to be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. During form removal, the Contractor shall ensure concrete is not damaged. The Contractor shall be responsible for the adequacy of the forming system. Forming material is to be thoroughly cleaned prior to reuse.

302.3.1.1 Coating: Before concrete placement coat the contact surfaces of forms with a non-staining mineral oil, non-staining form coating compound, or two (2) coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

302.3.1.2 Removal of Forms and Supports: After placing concrete, forms shall remain in place until the concrete has reached its design strength usually 28 days from the date of placement. Prevent concrete damage during form removal.

302.3.1.2.1 Special Requirements for Reduced Time-Period: Forms may be removed earlier than specified if the results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

302.3.2 FORMED SURFACES

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used.

Edges of all form panels in contact with concrete shall be flush within 1/8 inch in 5 feet. The maximum deviation of the finish wall surface at any point shall not exceed 1/4 inch from the intended surface as shown on the drawings.

All wood forms in contact with the concrete shall be coated with an effective, approved, releasing agent prior to form setting. Steel forms shall be thoroughly cleaned, and all mill scale and other ferrous deposits shall be sandblasted and removed from the contact surface.

302.3.3 INSPECTION

The Engineer shall be notified 24 hours prior to proposed concrete placement. Failure of the forms to comply with the requirements specified herein or to produce concrete complying with the requirements of this section shall be grounds for rejection of that portion of the concrete work. Rejected work shall be replaced or repaired as directed by the Engineer at no additional cost to the Owner. Such repairs or replacement shall be subject to the requirements of this section and approved by the Engineer.

302.4 MEASUREMENT AND PAYMENT

Measurement and payment for the work covered by this section of the specifications shall be considered incidental to the items of work described in the Special Conditions.

303 MASONRY - INDEX

303 MASONRY

303.1 GENERAL

303.1.1 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include but are not limited to the following:

I. Section 101, Submittal Procedures
II. Section 301, Cast-in-Place Concrete

303.1.2 SUBMITTALS

The following shall be submitted in accordance with Section 101:

303.1.2.1 Shop Drawings:

I. Detail Drawings

303.1.2.2 Product Data:

I. Cement
II. Cold Weather Installation

303.1.2.3 Samples:

I. Concrete Masonry Units (CMU)
II. Anchors, Ties and Bar Positioners
III. Expansion-Joint Materials
IV. Joint Reinforcement

303.1.2.4 Design Data:

I. Pre-mixed Mortar
II. Unit Strength Method

303.1.2.5 Test Reports:

I. Field Testing of Mortar
II. Field Testing of Grout
III. Prism Tests
IV. Masonry Cement

303.1.2.6 Certificates:

I. Concrete Masonry Units (CMU)
II. Anchors, Ties and Bar Positioners
III. Expansion-Joint Materials
IV. Joint Reinforcement
V. Masonry Cement
VI. Admixtures for Masonry Mortar
VII. Admixtures for Grout

303.1.2.7 Manufacturer's Instructions:

I. Masonry Cement

303.1.3 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered, stored, handled, and protected to avoid chipping, breakage and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

303.1.3.1 Masonry Units: Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C90.

303.1.3.2 Reinforcement, Anchors and Ties: Steel reinforcing bars, coated anchors, ties and joint reinforcements shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

303.1.3.3 Cementitious Materials, Sand and Aggregates: Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with the manufacturer’s names and brands. Cementitious materials shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination or segregation.

303.1.4 PROJECT/SITE CONDITIONS

Conform to ACI 530/530.1 for hot and cold weather masonry erection.

303.1.4.1 Hot Weather Installation: Take the following precautions if masonry is erected when the ambient air temperature is more than 99 degrees Fahrenheit in the shade and the relative humidity is less than 50 percent, or the ambient air temperature exceeds 90 degrees Fahrenheit and the wind velocity is more than eight (8) miles per hour (mph).

All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than four (4) feet ahead of masonry; masonry units shall be set within one

minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

303.1.4.2 Cold Weather Installation: Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees Fahrenheit or temperature of masonry units is below 40 degrees Fahrenheit, submit a written statement of proposed cold weather construction procedures for approval by the Engineer.

303.2 MATERIALS

303.2.1 GENERAL REQUIREMENTS

The source of materials, which will affect the appearance of the finished work, shall not be changed after the work has started without approval by the Engineer.

303.2.2 CONCRETE MASONRY UNITS (CMU)

Submit samples and certificates as specified herein. Cement shall have:

I. Low alkali content and be of one brand
II. Hollow Non-Load-Bearing Units: ASTM C129, made with lightweight or normal weight aggregate
    i. Load-bearing units may be provided in lieu of non-load-bearing units.

303.2.2.1 Aggregates: Lightweight aggregates and blends of lightweight and heavier aggregates, in proportions used in producing the units, shall be tested for stain-producing iron compounds in accordance with ASTM C641. The iron stain deposited on the filter paper shall not exceed the "light stain" classification as determined by the visual classification method. Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag and expanded slag in aggregates. Slag shall comply with ASTM C989/C989M; Grade 80.

303.2.2.2 Kinds and Shapes: Units shall be modular in size and shall include closer, jamb, header, lintel and bond beam units and special shapes and sizes to complete the work as indicated. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

303.2.2.2.1 Architectural Units: The architectural units shall have a patterned face shell. The face shell patterns shall be split ribbed. The units shall be integrally colored during manufacturing and the color shall be as chosen by the Owner. Patterned face shell shall be properly aligned in the completed wall.

303.2.3 MORTAR FOR STRUCTURAL MASONRY

Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar. Use up to 40 percent Class F fly ash with Type IP cement in cement-lime mortar. Fly ash shall comply with ASTM C593.

303.2.4 MASONRY MORTAR

Mortar Type S shall conform to the proportion specification of ASTM C270.

303.2.4.1 Admixtures for Masonry Mortar: In cold weather, a non-chloride based accelerating admixture may be used but is subject to approval of the Engineer. The accelerating admixture shall be non-corrosive, contain less than 0.2 percent chlorides, and conform to ASTM C494/C494M, Type C. Submit the required certifications in accordance with Section 101.

303.2.4.2 Colored Mortar: Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color that matches the colored CMU as close as possible. The mortar coloring shall be chemically inert, of finely ground lime proof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement. The compressive strength of colored mortar shall equal 2500 pounds per square inch (psi).

303.2.4.3 Hydrated Lime and Alternates: Hydrated lime shall conform to ASTM C207, Type S.

303.2.4.4 Cement: Portland cement shall conform to ASTM C150/C150M, Type I, II, or III. Masonry cement shall conform to ASTM C91, Type S. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this Section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required. Additives shall conform to requirements of Section 301.

303.2.4.5 Sand and Water: Sand shall conform to ASTM C144. Water shall be clean, potable and free from substances which could adversely affect the mortar.

303.2.5 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C476, fine. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Minimum grout strength shall be 2500 psi in 28 days, as tested by ASTM C1019. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless

additional evidence is furnished that the grout meets the specified requirements. Ready-mixed grout shall conform to ASTM C94/C94M.

303.2.5.1 Admixtures for Grout: In cold weather, a non-chloride based accelerating admixture may be used and is subject to approval of the engineer. The accelerating admixture shall be non-corrosive, contain less than 0.2 percent chlorides, and conform to ASTM C494/C494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Engineer.

303.2.5.2 Grout Barriers: Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass or expanded metal.

303.2.6 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A153/A153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A82/A82M. Wire ties or anchors in exterior walls shall conform to ASTM A641/A641M. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

Bar positioners, used to prevent displacement of reinforcing bars during construction, shall be factory fabricated from 9 Gauge steel wire or an approved equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

Submit two anchors, ties and bar positioners of each type used, as samples, in accordance with Section 101.

303.2.7 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A82/A82M, welded construction. Wire shall have a zinc coating conforming to ASTM A153/A153M, Class B-2, and shall be a minimum of 9 Gauge. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A641/A641M.

Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections.

Submit one piece of each type used, including corner and wall intersection pieces, showing at least two cross wires in accordance with Section 101.

303.2.8 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A615/A615M, Grade 60.

303.2.9 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural, synthetic rubber or combination thereof, conforming to ASTM D2000, or polyvinyl chloride conforming to ASTM D2287. The material shall also be resistant to oils and solvents.

The control joint key shall be provided with a solid shear section with a thickness not less than a 5/8 inch. The control joint key shall also have 3/8 inch thick flanges with a tolerance of plus or minus 1/16 inch. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves, shall be flexible at a temperature of negative (-) 30 degrees Fahrenheit after five hours of exposure, and have a durometer hardness of not less than 70 when tested in accordance with ASTM D2240.

303.2.10 EXPANSION JOINT MATERIALS

The backer rod and sealant for expansion joints shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be a compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or another flexible, non-absorptive material as recommended by the sealant manufacturer.

303.3 EXECUTION

303.3.1 PREPARATION

Prior to starting work, masonry shall be inspected by the Engineer for compliance and defects. The Contractor shall coordinate with the Engineer a time for inspection.

303.3.1.1 Protection: Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

303.3.1.2 Air Temperature Requirements for Items Being Constructed:

303.3.1.2.1 Air Temperature 32 to 40 degrees Fahrenheit: Sand or mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees Fahrenheit.

303.3.1.2.2 Air Temperature 25 to 32 degrees Fahrenheit: Sand and mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees Fahrenheit. Temperature of mortar on boards shall be maintained above freezing.

303.3.1.2.3 Air Temperature 20 to 25 degrees Fahrenheit: Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees Fahrenheit. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is more than 15 mph.

303.3.1.2.4 Air Temperature 20 degrees Fahrenheit and below: Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees Fahrenheit. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees Fahrenheit. Temperature of units when laid shall not be less than 20 degrees Fahrenheit.

303.3.1.3 Air Temperature Requirement Information for Completed Masonry and Masonry Not Being Constructed:

303.3.1.3.1 Mean Daily Air Temperature 32 to 40 degrees Fahrenheit: Masonry shall be protected from rain or snow for 24 hours by covering with a weather-resistant membrane.

303.3.1.3.2 Mean Daily Air Temperature 25 to 32 degrees Fahrenheit: Masonry shall be completely covered with a weather-resistant membrane for 24 hours.

303.3.1.3.3 Mean Daily Air Temperature 20 to 25 degrees Fahrenheit: Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

303.3.1.3.4 Mean Daily Temperature 20 degrees Fahrenheit and Below: Masonry temperature shall be maintained above 32 degrees Fahrenheit for 24 hours by enclosure and supplementary heat, electric heating blankets, infrared heat lamps, or other approved methods.

303.3.1.4 Loads: Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

303.3.1.5 Surfaces: Clean surfaces on which masonry is to be placed of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

303.3.2 LAYING MASONRY UNITS

Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in running bond pattern. Facing courses shall be level with back-up courses.

Units that have been disturbed after the mortar has stiffened shall be removed, cleaned and re-laid with fresh mortar. Air spaces, cavities, expansion joints, and spaces to be grouted

shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb.

Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a non-furrowed full bed of mortar. Units shall be shoved into place so that the vertical joints are tight. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below.

303.3.2.1 Forms and Shores: Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed less than 10 days after their installation.

303.3.2.2 Reinforced Concrete Masonry Units Walls: Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be two (2) x three (3) inches. Position reinforcement accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcement in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 1/2 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tie them together.

303.3.2.3 Concrete Masonry Units: Units starting courses on concrete slabs, lintels and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Jamb units shall be of the shapes and sizes to conform with wall units.

303.3.2.4 Tolerances: Lay masonry plumb, true to line, with courses level. Keep bond pattern plumb throughout. Square corners unless noted otherwise.

303.3.2.5 Cutting and Fitting: Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp.

303.3.2.6 Jointing: The joints shall be tooled when the mortar is "thumbprint hard". Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

303.3.2.6.1 Tooled Joints: The joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

303.3.2.7 Joint Widths: Joint widths shall be as follows:

303.3.2.7.1 Concrete Masonry Units: Concrete masonry units shall have 3/8 inch joints.

303.3.2.8 Embedded Items: Fill spaces around built-in items, such as embed anchors, accessories, pipe sleeves and other items required to be built-in as the masonry work progresses, with mortar. Fully embed anchors, ties and joint reinforcement set in mortar shall also have any spaces filled with mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout.

303.3.2.9 Unfinished Work: Step back unfinished work for joining with the new work. Toothing may be resorted to only when specifically approved. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

303.3.2.10 Masonry Wall Intersections: Masonry bond each course at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown on the contract drawings.

303.3.3 WEEP HOLES

Provide weep holes as indicated on the contract drawings. Weep holes shall be provided at approximately 10-foot on center, and shall be perfectly horizontal or slightly canted downward to encourage water drainage outward (not inward). Weep holes shall be made of PVC with insect screens on the back side to prevent gravel from exiting from behind the walls. Weep size shall be as indicated on the contract drawings. Weep holes shall be kept free of mortar and other obstructions. Other methods may be used for providing weep holes upon the Engineer's approval.

303.3.4 MORTAR MIX

The Contractor shall mix mortar in a mechanically operated mortar mixer for at least three (3) minutes, but not more than five (5) minutes. Measure ingredients for mortar by volume. The ingredients not kept in containers, such as sand, shall be accurately measured using

measuring boxes. Mix water with the dry ingredients in a sufficient amount to provide a workable mixture that will adhere to the vertical surfaces of masonry units. Re-temper mortar that has stiffened because of loss of water through evaporation by adding water to restore the proper consistency and workability. Discard mortar that has reached its initial set or that has not been used within two (2) hours after mixing.

303.3.5 REINFORCING STEEL

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, or other coatings which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within two (2) inches of tops of walls.

303.3.5.1 Positioning Bars: Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one (1) diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

303.3.5.2 Splices: Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

303.3.6 JOINT REINFORCEMENT INSTALLATION

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped no less than six (6) inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide no less than 5/8 inch cover to either face of the unit.

303.3.7 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units, cells under lintel bearings on each side of the openings, lintels, and bond beams shall be filled solid with grout. Cells under lintel bearings shall be filled the full height of openings.

Grout not in place within 1 1/2 hours of when water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

303.3.7.1 Vertical Grout Barriers for Fully Grouted Walls: Provide grout barriers no more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

303.3.7.2 Horizontal Grout Barriers: Horizontal grout barriers shall be embedded grout barriers in mortar below cells of hollow units receiving grout.

303.3.7.3 Grout Holes and Cleanouts:

Provide cleanout holes at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds five (5) feet. Where all cells are to be grouted, construct cleanout courses using bond beam units in an inverted position to permit cleaning of all cells. Provide cleanout holes at a maximum spacing of 32 inches where all cells are to be filled with grout. Establish a new series of cleanouts if grouting operations are stopped for more than four (4) hours. Cleanouts shall not be less than three (3) x four (4) inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

303.3.7.4 Grouting Equipment:

303.3.7.4.1 Grout Pumps: Pumping through aluminum tubes will not be permitted. Operate pumps to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, remove waste materials and debris from the equipment and dispose of it outside the masonry.

303.3.7.4.2 Vibrators: Internal vibrators shall maintain a speed of no less than 5000 impulses per minute when submerged in the grout. Maintain at least one (1) spare vibrator on site at all times. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of the vibration to time necessary to produce satisfactory consolidation without causing segregation.

303.3.7.5 Grout Placement: Lay masonry to the top of a pour before placing the grout. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state.

303.3.8 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints

or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

303.3.9 CONTROL JOINTS

Control joints shall be provided as indicate and shall be constructed by using mortar to fill the head joint in accordance with the details shown on the drawings.

303.3.10 LINTELS

303.3.10.1 Masonry Lintels: Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two (2) No. 4 bars in the bottom course (unless otherwise indicated on the drawings). Lintel reinforcement shall extend beyond each side of any masonry openings 40 bar diameters or 24 inches; whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

303.3.10.2 Precast Concrete and Steel Lintels: Construct precast concrete and steel lintels as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of eight (8) inches unless otherwise indicated on the drawings.

303.3.11 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs or splashings from masonry unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry that will be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high-pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stains and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

303.3.11.1 Dry-Brushing: Exposed concrete masonry units and exposed concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

303.3.12 BEARING PLATES

Set bearing plates for beams, joists, joist girders and similar structural members to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated.

303.3.13 PROTECTION

Protect facing materials against staining. Cover top of walls with non-staining waterproof covering or membrane when work is not in progress. The top of the unfinished walls shall continue to be covered until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of two (2) feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

303.3.14 TEST REPORTS

303.3.14.1 Field Testing of Mortar: A minimum of three (3) specimens of mortar per day shall be sampled and tested. Spread a layer of mortar 1/2 to 5/8 inch thick on the masonry units and allow to stand for one (1) minute. Prepare and test the specimens for compressive strength in accordance with ASTM C780. Submit test results.

303.3.14.2 Field Testing of Grout: Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C1019. A minimum of three (3) specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2500 psi at 28 days. Submit test results.

303.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be as set forth in the Special Conditions.

304 CURB & GUTTER, SIDEWALKS, DRIVE PAD, AND CONCRETE PAVEMENT CONSTRUCTION – INDEX

304 CURB & GUTTER, SIDEWALKS, DRIVE PAD, AND CONCRETE PAVEMENT CONSTRUCTION

304.1 GENERAL

304.1.1 DESCRIPTION

This section of the specifications covers concrete materials and construction methods for curb & gutter, sidewalks, drive pads and other concrete construction.

304.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections are:

I. Section 101, Submittal Procedures
II. Section 201, General Earthwork
III. Section 301, Cast-In-Place Concrete
IV. Section 302, Concrete Framework

304.1.3 SUBMITTALS

The following shall be submitted in accordance with Section 101:

I. Product Data
II. Concrete
III. Copies of certified delivery tickets for all concrete used in the construction.
IV. Test Reports
V. Field Quality Control
VI. Copies of all test reports within 24 hours of completion of the test.

304.1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

304.1.4.1 General Requirements: Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control, and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Engineer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

304.1.4.2 Slip Form Equipment: Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one (1) pass.

304.2 MATERIALS

304.2.1 CONCRETE

Concrete shall comply with Section 301 with these specifications. A Class "F" concrete matching specified strength requirement may only be used with slip form equipment and approval of mix design by the Engineer.

304.2.2 REINFORCEMENT STEEL

304.2.2.1 Reinforcement Bars: Shall conform with Section 301 and the following: ASTMA 615/A 615M, ASTM A 616/A 616M, or ASTM A 617/A 617M.

304.2.2.2 Wire Mesh Reinforcement: Shall conform to ASTM A 185.

304.2.3 MATERIALS FOR CURING CONCRETE

Materials for curing concrete shall adhere to the requirements of Section 301.

304.2.4 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of de-icing chemicals may be used, except that emulsified mixtures are not acceptable.

304.2.5 JOINT FILLER STRIPS

304.2.5.1 Contraction Joint Filler for Curb and Gutter: Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

304.2.5.2 Expansion Joint Filler, Premolded: Expansion joint filler, premolded, shall conform to ASTMD 1751 or ASTM D 1752, ½ inch thick, unless otherwise indicated.

304.2.6 JOINT SEALANTS

304.2.6.1 Joint Sealant, Cold-Applied: Joint sealant, cold-applied shall conform to ASTM C 920.

304.2.6.2 Joint Sealant, Hot-Poured: Joint sealant, hot-poured shall conform to ASTM D 3405.

304.2.7 FORM WORK

Form work shall be designed and constructed to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, two (2) inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 1/4 inch boards, bent to the required radius. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of three (3) welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

304.2.7.1 Sidewalk Forms: Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk. Handicapped sidewalks shall be constructed to include a 15:1 transition. Cross slopes, within the transition, shall not exceed 50:1.

304.2.7.2 Curb and Gutter Forms: Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1 ½ inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

304.2.7.3 Fillet and Valley Gutter Forms: Fillet and valley gutter forms shall have a height equal to the full depth of the fillet or valley gutter. Forms shall be broken at the flow line of the adjacent curbs and gutters.

304.2.7.4 Drive Pads: Drive pad forms shall have a height equal to the full depth of the drive pad. Forms shall be set to include a handicapped accessible route either at the high end or low end of the drive pad. Accessible routes constructed on the lower end shall include a 12:1 transition.

304.2.8 CONCRETE PAVEMENT

Concrete pavement for trench patch shall be in accordance with Section 301. Concrete shall be placed at the thickness called for. Joint pattern shall match existing pavement. Pavement is to be finished by transverse brooming with a coarse broom.

304.2.9 CONCRETE CUTS

Saw cuts shall be provided where partial concrete removal is required in existing slabs with no nearby joints. Cuts shall be of adequate depth to produce a clean vertical break with no undercut.

304.3 EXECUTION

304.3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross-section prior to concrete placement. Subgrade shall be placed and compacted as indicated on the contract drawings.

Areas over trench construction shall not be formed for concrete construction until density tests indicate compaction is adequate. Subgrade shall be accurately graded and tamped prior to setting forms. No backfilling shall be performed after forms are set. All loose dirt shall be removed prior to pouring. Subgrade preparation shall also conform to Section 203 of these specifications.

Subgrade composed of rock chunks or clay that cannot be adequately tamped or graded shall be replaced with granular fill.

304.3.1.1 Sidewalk Subgrade: The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

304.3.1.2 Curb and Gutter Subgrade: The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

304.3.1.3 Fillet and Valley Gutter Subgrade: The subgrade shall be tested for grade and cross section by means of a template extending the full width of the fillet and/or curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

304.3.1.4 Drive Pad Subgrade: The subgrade shall be tested for grade and cross section by means of a template extending the full width of the drive pad. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent curbs and gutters.

304.3.1.5 Maintenance of Subgrade: The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

304.3.2 FORM SETTING

Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of three (3) stakes per form placed at intervals not to exceed four (4) feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

304.3.2.1 Sidewalks: Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope 1/4 inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

304.3.2.2 Curbs and Gutters: The forms of the front of the curb shall be removed not less than two (2) hours nor more than six (6) hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

304.3.2.3 Fillet and Valley Gutter: Forms for fillets and valley gutters shall be set with edges true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, they shall be checked for proper slope. Forms that are transverse to the street traffic shall be broken to accommodate for the flow line between adjacent curbs and gutters. Traffic shall not be allowed on concrete for seven (7) days after placement or until concrete has reached 85 percent of the design strength.

304.3.2.4 Drive Pads: Forms for drive pads shall be set with edges true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set,

they shall be checked for proper slope. Forms that are transverse to the street traffic shall be set to provide for the depth shown on the contract drawings. Traffic shall not be allowed on concrete for seven (7) days after placement or until concrete has reached 85 percent of the design strength.

304.3.3 WEATHER LIMITATIONS

304.3.3.1 Placing During Cold Weather: Concrete placement shall not take place when the air temperature reaches 40 degrees Fahrenheit and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees Fahrenheit and is rising, or is already above 40 degrees Fahrenheit. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees Fahrenheit, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees Fahrenheit. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees Fahrenheit for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

304.3.3.2 Placing During Warm Weather: The temperature of the concrete as placed shall not exceed 85 degrees Fahrenheit except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees Fahrenheit at any time.

304.3.4 SIDEWALK CONCRETE PLACEMENT AND FINISHING

304.3.4.1 Formed Sidewalks: Concrete shall be placed in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

304.3.4.2 Concrete Finishing: After straight-edging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

304.3.4.3 Edge and Joint Finishing: All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be

edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

304.3.4.4 Surface and Thickness Tolerances: Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10 foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

304.3.5 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

304.3.5.1 Formed Curb and Gutter: Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

304.3.5.2 Curb and Gutter Finishing: Approved slipformed curb and gutter machines may be used in lieu of hand placement.

304.3.5.3 Concrete Finishing: Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

304.3.5.4 Joint Finishing: Curb edges at formed joints shall be finished as indicated.

304.3.5.5 Surface and Thickness Tolerances: Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10 foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

304.3.6 CONCRETE FILLET, VALLEY GUTTER AND DRIVE PAD PLACEMENT AND FINISHING

304.3.6.1 Formed Fillets, Valley Gutters and Drive Pads: Concrete shall be placed in the forms in one layer. When consolidated and finished, the fillets and valley gutters shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

304.3.6.2 Concrete Finishing: After straight-edging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

304.3.6.3 Edge and Joint Finishing: All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

304.3.6.4 Surface and Thickness Tolerances: Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10 foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

304.3.7 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or five (5) feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

304.3.7.1 Sidewalk Contraction Joints: The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least 1/4 of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one (1) standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

304.3.7.2 Sidewalk Expansion Joints: Expansion joints shall be formed with 1/2 inch joint filler strips. Joint filler shall be placed with top edge one (1) inch below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be

cleaned and filled with a 1/2 inch backer rod and 1/2 inch of joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees Fahrenheit at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

304.3.8 FILLET, VALLEY GUTTER AND DRIVE PAD JOINTS

Fillet, valley gutter and drive pad joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or five (5) feet on centers, whichever is less, and shall be continuous across the slab.

304.3.8.1 Valley Gutter and Drive Pad Contraction Joints: The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least 1/4 of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one (1) standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

304.3.8.2 Reinforcement Steel Placement: Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

304.3.9 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

304.3.9.1 Contraction Joints: Contraction joints shall be constructed directly opposite of contraction joints in abutting Portland cement pavements and spaced so that monolithic sections between curb returns will not be less than five (5) feet nor greater than 15 feet in length. Contraction joints shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

304.3.9.2 Expansion Joints: Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting Portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut Portland cement concrete pavement, expansion joints at least 1/2 inch in width shall be provided at intervals not

exceeding 30 feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Expansion joints and the top one (1) inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees Fahrenheit at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

304.3.10 CURING AND PROTECTION

304.3.10.1 General Requirements: Concrete shall be protected against loss of moisture and rapid temperature changes for at least seven (7) days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

304.3.10.1.1 Mat Method: The entire exposed surface shall be covered with two (2) or more layers of burlap. Mats shall overlap each other at least six (6) inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than seven (7) days.

304.3.10.1.2 Impervious Sheeting Method: The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18 inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than seven (7) days.

304.3.10.1.3 Membrane Curing Method: A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than one (1) hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If

any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two (2) coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasions, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within three (3) hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

304.3.10.2 Backfilling: After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

304.3.10.3 Protection: Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

304.3.11 FIELD CONTROL

304.3.11.1 General Requirements: The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing.

Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below and any additional tests to ensure that the requirements of these specifications are met.

304.3.11.2 Concrete Testing:

304.3.11.2.1 Strength Testing: The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken no less than once a day nor less than once for every 50 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of two (2) test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three (3) consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 pounds per square inch (psi).

304.3.11.2.2 Air Content: Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two (2) tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman. If results are out of tolerance, the placing foreman shall be notified, and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until the air content is within the tolerance specified.

304.3.11.2.3 Slump Test: Two (2) slump tests shall be made on randomly selected batches of each class of concrete for every 50 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

304.3.11.2.4 Temperature Tests: Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions below 50 degrees Fahrenheit and above 80 degrees Fahrenheit for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

304.3.11.3 Thickness Evaluation: The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior

to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

304.3.11.4 Surface Evaluation: The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

304.3.12 SURFACE DEFICIENCIES AND CORRECTIONS

304.3.12.1 Thickness Deficiency: When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

304.3.12.2 High Areas: In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed five (5) percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

304.3.12.3 Appearance: Exposed surfaces of the finished work will be inspected and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

304.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the specifications shall be in accordance with provisions of the Special Conditions.

402 BASE COURSE MATERIAL - INDEX

402 BASE COURSE MATERIAL

402.1 GENERAL

Base course for roads (paved and graveled), asphalt patch under concrete, curb & gutter, sidewalk, walls, valley gutters, fillets, driveways and parking areas shall conform to the dimensions and sections as shown on the project drawings. Gravel shall be placed on firm, compacted, accurately graded subgrade after all utility lines and appurtenances have been installed. Gravel is to be placed at near optimum moisture and rolled to achieve densities of 90 percent Modified Proctor. The final gravel surface shall be smooth and uniform with accurate lateral and vertical dimensions called for.

402.1.1 DESCRIPTION

This item of work shall consist of furnishing all material, supplies, plant and labor required for construction of gravel roads and driveways complete in accordance with applicable provisions of these specifications and project drawings.

402.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this section. Related sections are:

I. Section 101, Submittal Procedures
II. Section 201, General Earthwork
III. Section 203, Trenching, Excavation, and Backfilling
IV. Section 401, Hot Mix Bituminous Pavement

402.1.3 DEFINITIONS

For the purposes of this specification, the following definitions apply.

402.1.3.1 Aggregate Base Course: Aggregate Base Course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

402.1.3.2 Degree of Compaction: Degree of compaction required is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 or AASHTO T 180 Method D and corrected with AASHTO T 224 abbreviated as a percent of laboratory maximum dry density.

402.1.4 SUBMITTALS

402.1.4.1 Product Data:

I. Plant, Equipment, and Tools
II. List of proposed equipment to be used in performance of construction work, including descriptive data.

402.1.4.2 Delivery Tickets: Copies of delivery tickets during the progress of the work.

402.1.4.3 Test Reports:

I. Sampling and Testing
II. Field Density Tests
III. Certified copies of test results for approval no less than 10 days before material is required for the work.
IV. Calibration curves and related test results prior to using the device or equipment being calibrated.
V. Copies of field test results within seven (7) days after the tests are performed.

402.1.5 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved by the Engineer. Work requiring testing will not be permitted until the testing laboratory has been approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Engineer may specify the time and location of the tests. Copies of test results shall be furnished to the Engineer within seven (7) days of completion of the tests.

402.1.5.1 Sampling: Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Engineer.

402.1.5.2 Tests: The following tests shall be performed in conformance with the applicable standards listed.

402.1.5.2.1 Sieve Analysis: Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

402.1.5.2.2 Liquid Limit and Plasticity Index: Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

402.1.5.2.3 Moisture-Density Determinations: The laboratory maximum dry density and optimum moisture content shall be determined in accordance with AASHTO T 180, Method D and corrected with AASHTO T 224.

402.1.5.2.4 Field Density Tests: Density shall be field measured in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 2922.

402.1.5.3 Testing Frequency:

402.1.5.3.1 Initial Tests: Tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one (1) source is going to be utilized, this testing shall be completed for each source.

402.1.5.3.2 In Place Tests: Each of the following tests shall be performed on samples taken from the placed and compacted ABC. Samples shall be taken and tested at the rates indicated. Sampling and testing of recycled concrete aggregate shall be performed at twice the specified frequency until the material uniformity is established.

I. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 250 square yards, or portion thereof, of completed area.
II. Sieve Analysis shall be performed on every lift of material placed and at a frequency of one sieve analysis for every 1500 square yards, or portion thereof, of material placed.
III. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.
IV. The total thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards of base course. Measurements shall be made in three (3) inch diameter test holes penetrating the base course.

402.1.5.4 Approval of Material: The source of the material shall be selected 15 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted course(s).

402.1.6 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 35 degrees Fahrenheit. When the temperature falls below 35 degrees Fahrenheit, the Contractor shall

protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements. Additional testing may be required at Contractor's expense.

402.1.7 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work shall be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

402.1.8 DELIVERY TICKETS

Before the final statement is allowed, the Contractor shall file certified delivery tickets for all aggregates used, as specified in the submittals paragraph.

402.2 MATERIALS

402.2.1 AGGREGATES

The ABC shall consist of clean, sound, durable particles of crushed stone, crushed slag, crushed gravel, crushed recycled concrete, angular sand, or other approved material. ABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve shall be known as coarse aggregate; that portion passing the No. 4 sieve shall be known as fine aggregate.

402.2.1.1 Coarse Aggregate: Coarse aggregates shall be angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

I. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.
II. Crushed Stone: Crushed stone shall consist of freshly mined quarry rock, and shall meet all the requirements specified below.
III. Crushed Recycled Concrete: Crushed recycled concrete shall consist of previously hardened Portland Cement concrete or other concrete containing pozzolanic binder material. The recycled material shall be free of all reinforcing steel, bituminous concrete surfacing, and any other foreign material and shall be crushed and processed to meet the required gradations for coarse aggregate. The recycled concrete aggregate shall have a percent of expansion not to exceed 0.08 percent, when tested in accordance with ASTM C 1260. Recycled concrete

aggregate exceeding this value shall be rejected. Crushed recycled concrete shall meet all other applicable requirements specified below.

402.2.1.1.1 Aggregate Base Course: ABC coarse aggregate shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one (1) having a ratio of width to thickness greater than three (3); an elongated particle is one having a ratio of length to width greater than three (3). In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two (2) or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest mid sectional area of the piece. When two (2) fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two (2) fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in Table 1.

402.2.1.2 Fine Aggregate: Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

402.2.1.2.1 Aggregate Base Course: ABC fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

402.2.1.3 Gradation Requirements: The specified gradation requirements shall apply to the completed base course. The aggregates shall be continuously well graded within the limits specified in Table 1. Sieves shall conform to ASTM E 11.

The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, they shall be tested in accordance with ASTM C 127 and ASTM C 128 to determine their specific gravities. If the specific gravities vary by more than 10 percent, the percentages passing the various sieves shall be corrected.

402.2.2 LIQUID LIMIT AND PLASTICITY INDEX

Liquid limit and plasticity index requirements shall apply to the completed course and shall also apply to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the No. 40 sieve shall be either non-plastic or have a liquid limit not greater than 25 and a plasticity index not greater than five (5).

402.2.3 BASE COURSE FOR PAVED ROAD, DRIVEWAYS AND PARKING LOTS

Base course thickness shall be as shown on the project drawings. The base course furnished shall be crushed aggregate conforming to ADOT specifications with one of the following gradation requirements as called for:

TABLE 1: BASE COURSE GRADATION

Class of Aggregate	Percent Passing Sieve (Inch or No.)							P.I., Max.
	3	1-1/2	1	3/4	1/4	8	200	
1			100	90-100		35-55	0-8.0	3
2		100	90-100			35-55	0-8.0	3
3								
4	100				35-70		0-10.0	5
5	100				30-75		0-10.0	5
6								

L.A. Abrasion to be 50 or less.

Base course shall be placed at or near optimum moisture content to achieve densities of 95 percent or better (as called for) of Modified Proctor (AASHTO T-180-95, Method D). Base course shall be accurately graded so that subsequent asphalt layers will be of proper thickness.

402.3 EXECUTION

402.3.1 GENERAL REQUIREMENTS

Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

402.3.2 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specifications requirements in the specified time limit.

402.3.3 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

402.3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the base course(s), the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the base course(s), the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the base course(s). Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the base course is placed.

402.3.5 INSTALLATION

402.3.5.1 Mixing the Materials: The coarse and fine aggregates shall be mixed in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. The Contractor shall make adjustments to mixing procedures or equipment as directed to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory base course meeting all requirements of this specification. Adjustments to the JMF shall be limited to ± five (5) percent on the No. 4 sieves; ± five (5) percent on the No. 30 sieve, and ± three (3) percent on the No. 200 sieve.

402.3.5.2 Placing: The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. A compacted layer of material shall be placed in a single layer when a thickness of six (6) inches is required. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be

directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable base course.

402.3.5.3 Grade Control: The finished and completed base course shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required base course thickness so that the finished base course and the subsequent surface course will meet the designated grades.

402.3.5.4 Edges of Base Course: The base course(s) shall be placed so that the completed section will be a maximum of 12 inches wider than the typical road section, back of curb to back of curb, on all sides.

402.3.5.5 Compaction: Base course shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within ± two (2) percent of the optimum water content determined from laboratory tests as specified in Paragraph 402.1.5 of this Section. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer has a degree of compaction that is at least 96 percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

402.3.5.6 Thickness: Compacted thickness of the base course shall be as indicated. The total compacted thickness of the base course(s) shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, re-blading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The total thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards of base course.

402.3.5.7 Finishing: The surface of the top layer of base course shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet

grade. If the elevation of the top layer of base course is 1/2 inch or more below grade, then the top layer should be scarified to a depth of at least three (3) inches and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

402.3.5.8 Smoothness: The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 12-foot straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50-foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

402.3.6 TRAFFIC

Completed portions of the base course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

402.3.7 MAINTENANCE

The base course shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any base course that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of base course that is damaged shall be reworked or replaced as necessary to comply with this specification.

402.3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of in accordance with all state and local requirements at no additional cost to the Owner. No additional compensation shall be made for materials that must be replaced.

402.4 MEASUREMENT & PAYMENT

Measurement and payment for the work covered by this section of the specifications shall be considered incidental to the items of work described in the Special Conditions.

404 GRAVEL ROADS AND DRIVEWAYS - INDEX

404 GRAVEL ROADS AND DRIVEWAYS

404.1 GENERAL

Gravel roads, driveways, and parking areas shall conform to the dimensions and sections as shown on the project drawings. Gravel shall be placed on firm, compacted, accurately graded subgrade after all utility lines and appurtenances have been installed. Gravel is to be placed at near optimum moisture and rolled to achieve densities of 90 percent Modified Proctor. The final gravel surface shall be smooth and uniform with accurate lateral and vertical dimensions called for.

404.1.1 DESCRIPTION

This item of work shall consist of furnishing all material, supplies, plant, and labor required for construction of gravel roads and driveways complete in accordance with applicable provisions of these specifications and project drawings.

404.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections are:

I. Section 402, Base Course Material

404.2 MATERIALS

404.2.1 GRAVEL MATERIAL REQUIREMENTS

Gravel provided shall meet requirements for NMSHTD base course as specified in Section 402.

404.3 EXECUTION

404.3.1 INSTALLATION

404.3.1.1 Placing: The material shall be placed on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. A compacted layer of material shall be placed in a single layer when a thickness of six (6) inches is required. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one (1) layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable base course.

404.3.1.2 Grade Control: The finished and completed base course shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required base course thickness so that the finished base course and the subsequent surface course will meet the designated grades.

404.3.1.3 Edges of Base Course: The base course(s) shall be placed so that the completed section will be a maximum of 12 inches wider than the typical road section, back of curb to back of curb, on all sides.

404.3.1.4 Compaction: Base course shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within ± two (2) percent of the optimum water content determined from laboratory tests as specified in Section 402. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer has a degree of compaction that is at least 96 percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

404.3.1.5 Thickness: Compacted thickness of the base course shall be as indicated. The total compacted thickness of the base course(s) shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, re-blading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The total thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards of base course.

404.3.1.6 Finishing: The surface of the top layer of base course shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of base course is 1/2 inch or more below grade, then the top layer should be scarified to a depth of at least three (3) inches and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to

completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

404.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of the specifications shall be as set forth in the Special Conditions.

501 WATER LINES AND APPURTENANCES - INDEX

501 WATER LINES AND APPURTENANCES

501.1 GENERAL

501.1.1 DESCRIPTION

This item of work shall consist of furnishing all materials, supplies, plant and labor required for construction of water lines and appurtenances complete in accordance with applicable provisions of these specifications and the project drawings.

501.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include but are not limited to the following:

I. Section 101, Submittal Procedures
II. Section 203, Trenching, Excavation, and Backfilling
III. Section 204, Fill Materials
IV. Section 301, Cast-In-Place Concrete
V. Section 503, Station Valves, Piping, Appurtenances, and Associated Painting

501.1.3 SUBMITTALS

Engineer approval is required for submittals. The following shall be submitted in accordance with Section 101.

505.1.3.1 Product Data:

I. Water distribution main piping, fittings, joints, couplings, and appurtenances
II. Valves, hydrants, and appurtenances
III. Meters and appurtenances
IV. Water service line piping, fittings, joints, valves, couplings, and appurtenances

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

505.1.3.2 Test Reports:

I. Bacteriological disinfection
II. Test results shall be from a certified commercial laboratory verifying disinfection

501.1.3.3 Certificates: Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within three (3) years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project. The contractor shall provide certificates for the following:

I. Water distribution main piping, fittings, joints, couplings, and appurtenances
II. Valves, hydrants, and appurtenances
III. Meters and appurtenances
IV. Water service line piping, fittings, joints, valves, couplings, and appurtenances
I. Manufacturer's instructions
II. Delivery, storage, and handling
III. Installation procedures for water piping

501.1.4 DELIVERY, STORAGE, AND HANDLING

501.1.4.1 Delivery and Storage: Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials, and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, and hydrants free of dirt and debris. Pipe that is left unprotected and that receives storm runoff water shall be removed, cleaned and approved prior to resuming construction. Pipe that is infiltrated by sewage shall be removed from the project and replaced at no additional cost to the owner.

501.1.4.2 Handling: The Contractor shall handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the assigned location undamaged. Take special care to avoid injury to coatings and linings on pipe and fittings. The Contractor shall make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been applied. Carry, do not drag, pipe to the trench. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Owner. Store rubber gaskets that are not to be installed immediately under cover and out of direct sunlight.

501.1.4.3 Miscellaneous Plastic Pipe and Fittings: Handle Polyvinyl Chloride (PVC) pipe and fittings in accordance with the manufacturer's recommendations. Store plastic piping and jointing materials, that are not to be installed immediately, under cover and out of direct sunlight. Storage facilities shall be classified and marked in accordance with NFPA 704, NFPA 49, and NFPA 325.

501.2 MATERIALS

Water lines, fire hydrants, valves and appurtenances shall be installed at the locations shown on the drawings. All materials incorporated in the work shall be NSF 61 approved, new and unused, of the quality specified herein and shall be installed in accordance with the recommendations of the manufacturer.

501.2.1 PIPES, FITTINGS, AND APPURTENANCES

Pipe for water mains shall be of material called for on the project drawings and shall meet specifications below.

501.2.1.1 Ductile Iron Piping: Water lines, unless otherwise specified, shall be Class 350 ductile iron pipe. The pipe shall be cement lined and shall meet the requirements of AWWA Specifications C104 and C151. Joints for ductile iron pipe shall be rubber gasket push-on type or restrained joint as called for on the drawings. Restrained ductile iron pipe joints called for on project drawings shall have push on joints with ductile iron locking elements independent of gasket. Pipe shall be US pipe TR flex or equal. External joint restraints are not permitted.

Fittings shall be ductile iron fittings as specified in Paragraph 501.2.1.3.

501.2.1.2 PVC Water Pipe: Pipe four (4) inches through 36 inches diameter, shall meet the requirements of AWWA C900, "Standard for Polyvinyl Chloride Pressure Pipe." PVC pipe shall be furnished with outside diameters equivalent to cast iron pipe with rubber gasket joints as listed in above paragraph. PVC pipe shall be furnished in the pressure class and DR designation per the latest edition of AWWA C900 as listed on the project drawings.

PVC pipe of IPS sizes 1.5 to 3.0 inches with "slip-on" connections shall conform to ASTM D2241. The DR (dimension ratio) shall be specified.

Fittings shall be ductile iron fittings as specified Paragraph 501.2.1.3 unless otherwise called for.

501.2.1.3 Ductile Iron Pipe Fittings: Fittings shall be cement lined, ductile iron, with mechanical joints or flanged joints as called for in the project documents. Fittings shall conform to the requirements of AWWA Specifications C104 and C110, provided however, that ductile iron mechanical joint fittings, such as U.S. Pipe Trim Tyte conforming to AWWA C153 (in sizes available), or equal, are acceptable. Mechanical joint glands shall be Megalug, or equal, and suited for pipe material used. Fittings shall be Class 350 for 12 inch pipe and smaller. Fitting larger than 12 inches shall be rated to match adjoining pipe pressure rating with a minimum pressure rating of Class 250.

Fittings also include adaptor gasket required for transition between ductile iron pipe diameter to PVC SDR 21 pipe I.P.S. diameter.

501.2.1.4 Glass Reinforced Polymer (GRP) Pipe: Glass reinforced polymer pipe shall be installed at locations designated on the project drawings. GRP pipe shall conform to requirements of AWWA C950 and ASTM D3517 and have a pressure rating of 250 psi (pounds per square inch). Pipe stiffness shall be as called for, or as required, to exceed long term (50 year) deflection requirements.

Unrestrained joints shall consist of glass reinforced plastic sleeve couplings that utilize elastomeric sealing gaskets to maintain the water tightness meeting performance requirements of ASTM D4161. GRP pipe outside diameter shall be equal to that of cast iron pipe.

Restrained joints shall utilize glass reinforced plastic sleeves with elastomeric sealing gaskets (per ASTM D4161). Restrained joint coupling and spigot ends shall have matching grooves for installing a locking, non-metallic, shear restraint rod to complete the connection. All joints at GRP fittings shall be restrained joints.

GRP pipe shall be as manufactured by US Composite Pipe South or approved equal.

Fittings shall be GRP fittings unless otherwise called for or at connections to other pipe materials.

501.2.1.4.1 Glass Reinforced Polymer (GRP) Fittings: Elbows, reducers, and tees shall be of the same structural design as adjoining pipe. Fittings manufactured with mitered section of pipe shall be overlaid with fiber-glass. All fittings shall utilize elastomeric sealing gaskets (per ASTM D4161) and shall be restrained with a groove for installing a locking, non-metallic, shear resistant rod to complete connection to GRP pipe. Fittings shall be restrained type rated for 250 psi.

501.2.1.5 Steel Pipe: Steel pipe shall be of the minimum schedule as called for with minimum yield strength of 35 thousand pounds per square inch. Pipe shall be coated as called for in project documents. Fittings shall be weld neck type beveled for welding.

501.2.1.6 Polyethylene Pipe: Pipe shall be HDPE (High Density Polyethylene) conforming to AWWA C901/C906 specifications.

501.2.1.7 Ductile Iron Plastic Encasement: Encasement shall be polyethylene plastic conforming to AWWA C105. Two (2) layers shall be installed on all ductile iron pipe and fittings for buried service. Layers shall consist of a single layer of V-Bio polyethylene plastic followed by eight (8) mil. polyethylene plastic with staggered joints.

501.2.1.8 Warning Tape: Polyethylene plastic warning tape shall be manufactured specifically for warning and identification of existing buried utility lines. Tape rolls shall be three (3) inches minimum in width, color coded as specified for the intended utility, and have warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification shall read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Permanent color and printing shall be unaffected by moisture or soil exposure. Warning tape color for water systems shall be blue.

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Tape shall have a minimum thickness of 0.003 inches and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise and a maximum of 350 percent elongation.

501.2.1.9 Detection Wire: Wire shall be insulated single strand, solid copper detection wire with a minimum of 12AWG.

501.2.2 VALVES AND HYDRANTS

501.2.2.1 Gate Valves: Buried gate valves, two (2) inches and larger, shall be NRS resilient wedge type conforming to AWWA C509 (and AWWA C515 when larger than 12 inches). Gate valves shall have a factory applied epoxy coating (3 coat or fusion bond system), interior and exterior, conforming to AWWA C550. Valves shall be mechanical joint or flanged by MJ as called for. Buried valves shall have a two (2) inch AWWA operating nut. Exposed valves shall be equipped with operator hand wheels.

Valve body fasteners shall be Type 316 stainless steel. The sealing mechanism shall consist of a cast iron or ductile iron gate with a resilient wedge and shall be bonded or mechanically attached. It shall be designed to seal when unbalanced-balanced pressure is applied to either side of the gate. The sealing mechanism shall provide no leakage at 250 psi or less, working pressure with line flow in either direction. Valve shall turn clockwise to close.

Buried gate valves shall be installed in the horizontal position when so designated and be equipped with bevel gear. Valves 18 inch and larger in size shall have bypass lines. Bypass lines with valves shall be equipped with two (2) inch operating nuts. Bypass lines and valves shall be of the sizes listed below:

Main Valve Size	Bypass Valve Size
18", 20"	2"
24"	2½"
30"	3"

Main valves in the horizontal position shall be operated with bevel gearing. Valve boxes with appurtenances as detailed shall be installed for all buried valves.

501.2.2.1.1 Gate Valve Boxes: Provide a valve box for each gate valve on buried piping. Valve boxes shall be of cast iron of a size suitable for the valve on which it is to be used and shall be adjustable two-piece screw type with 5 1/4 inch shafts. Cast-iron boxes shall have a minimum cover and wall thickness of 1/4 inch as indicated. Cast-iron box shall have a heavy coat of bituminous paint. Valve boxes shall be suitable for finished bury without full extension.

501.2.2.2 Butterfly Valves: Butterfly valves shall conform to ANSI/AWWA C504 standard as Mueller or approved equal. Valves shall be class 150 with actuator for buried service and have a two (2) inch standard AWWA nut. Nut shall turn clockwise to close. Fasteners shall be 304 or 316 stainless steel.

501.2.2.2.1 Butterfly Valve Boxes: Provide a valve box for each gate valve on buried piping. Valve boxes shall be of cast iron of a size suitable for the valve on which it is to be used and shall be adjustable two-piece screw type with 5 1/4 inch shafts. Cast-iron boxes shall have a minimum cover and wall thickness of 1/4 inch as indicated. Cast-iron box shall have a heavy coat of bituminous paint. Valve boxes shall be suitable for finished bury without full extension.

501.2.2.3 Check Valve: Valve shall be AWWA C508 or UL 312 with bronze facing, lever arm, weight and provisions for temporarily holding valve open where called for. Valve to have stainless steel nuts and bolts and shall be epoxy coated. Valves shall be mechanical joint or flanged as called for and be rated for the working pressure as specified.

501.2.2.4 "T" Handle Valve Operator: Buried gate valves shall be furnished with one (1) operating wrench with "T" handle and socket to fit a two (2) inch square wrench nut for every eight (8) buried valves installed. The "T" wrench length shall be eight (8) ft.

501.2.2.5 Hydraulic Valve Operator: Valve operator shall be suitable for one (1) or two (2) man operation. Operator shall be capable of generating up to 350-foot pounds of torque. Operator shall have key shaft sections, when connected, capable of reaching the two (2) inch operating nut at depths of four (4) feet below ground level with handles for operating personnel at waist level. A hydraulic valve operator shall be furnished on a project with four (4) or more buried valves 16 inches or larger. One (1) actuator shall be supplied for every ten (10) buried valves 16 inches or larger installed.

Hydraulic system shall be capable of operating with hydraulic fluid flows of 3.5-10 gallons per minute (gpm) at 1750 to 2250 psi. Operator shall be capable of being used as a manual wrench with appropriate locking devices.

501.2.2.5.1 Electronic Turn Counter: LCD counter shall give numeric display of turns to open with reverse count for turns to close. Counter shall be self-contained with seven (7) year lithium battery.

501.2.2.5.2 Torque Control: Torque control knob and display shall allow for torque adjustment from ZERO at no torque to maximum allowed by system hydraulic pressure.

501.2.2.5.3 Hydraulic Hose Pigtails: Hydraulic connects shall be quick disconnect male and female, 3/8 inch flush face.

501.2.2.5.4 Equal Product: Hydraulic Valve Operator shall be the EXERCISER by Transmate, a division of Romac Industries Inc. or approved equal.

501.2.2.6 Vacuum and Air Relief Valves: Vacuum and air relief valves shall be of the size shown on the contract drawings and shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water. It shall also admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be cast iron body with stainless steel trim and float and full ported valves. Table @@@ provides recommendations for various valves.

TABLE @@@@: VALVE RECOMMENDATIONS

Air Valve Type	Model
Basic Air Vacuum Valves	Valvmatic Models VM-101 through VM-104 or equal
Air Release Valves	Valvmatic Models 22.9 through 50 or equal
Combination Air Valves (Single Body Type)	Valvmatic Models 201 C.2 through 204 C.2 or equal
Combination Air Valves (Dual Body Type)	Valvmatic Model 104/38 or equal

Valves and appurtenances shall be rated for 250 psi working pressure provided, however, that valves with 125 pound flanged inlets are shall be rated for 150 psi working pressure. Valves shall be equipped with low pressure seats when called for.

Hooded valves shall be equipped with stainless steel inlet screens.

501.2.2.7 Fire Hydrant Assembly: Fire hydrants shall have a six (6) inch diameter inlet with mechanical joint connection. Inlet shall have mechanical-joint end only. The end shall conform to the applicable requirements as specified for the joint. The hydrant shall be designed for 250 psi maximum working pressure and shall be equipped with two (2), 2

1/2 inch standard hose connections, and one (1), 4 1/2 inch pumper connection. Hydrants shall be dry-barrel type conforming to AWWA Specification C502 and shall have a minimum 5 1/4 inch valve opening. Normally, hydrants shall have four (4) feet minimum pipe cover, provided however, that grade conditions behind curbs or at fire hydrant locations are sometimes different and require taller fire hydrant barrels. Contractor shall note depth requirements on project drawings and provide barrels of proper height.

All fire hydrant bolts and nuts below grade shall be stainless steel. Fire hydrants shall be Mueller Super Centurion unless otherwise specified.

501.2.2.8 Post Indicator Valves: Post indicator valves shall consist of a UL 263 listed, FM 1120/1130 approved. AWWA C515 non-rising stem gate valve shall have UL listed indicator post. Gate valve shall have a triple o-ring seal, AWWA C550 epoxy coating, two (2) inch operating nut, and a stuffing box bolted with stainless steel fasteners. Indicator posts shall be adjustable type, indicate valve position, have a tamper proof operating wrench with padlock, and 1/2 inch NPT cast boss in upper barrel for a supervisory switch to be installed.

501.2.2.9 Sanitary Freeze Proof Yard Hydrants: Hydrants shall be Woodford Model S4H or equal with ASSE 1052 double check backflow preventer and reservoir below frost line. The reservoir is emptied when flow occurs through the 3/4 inch hose bib nozzle with no resultant soil contact.

501.3 EXECUTION

501.3.1 GENERAL INSTALLATION OF WATER PIPELINES

These requirements shall apply to all pipeline installation except where specific exception is made in the "Special Requirements" paragraphs detailed in the bid proposal.

501.3.1.1 Location of Water Lines: The location of water lines shall be referred to in the project drawings.

501.3.1.2 Earthwork: Trenching, Excavation, and Backfilling for water lines and accessories shall be in accordance with provisions of Section 203 of these specifications. Select granular material per Section 204 shall be provided as backfill in areas of rock excavation and where called for.

501.3.1.3 Pipe Laying and Jointing: Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches.

Cut pipe in a neat, work-person-like, manner accurately to the length established at the site and work into place without springing or forcing. Any pipe or fitting that does not allow sufficient space for proper installation of jointing material shall be replaced with that of proper length. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying.

Grade the pipeline in straight lines and avoid the formation of dips and low points. Support pipe at proper elevation and grade. Secure with firm and uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings.

Spigot ends shall be inserted so that the "Stop Line" is at the edge of the bell. Care shall be taken to ensure that the insertion depth is not exceeded on previous joints when making up a particular joint. Joint deflections shall accommodate vertical or horizontal change in directions but shall not exceed the allowable deflection recommended by the pipe manufacturer. Fittings shall be used in making direction changes requiring joint deflections greater than that recommended by the pipe manufacturer. Provide anchors and supports where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines.

Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Work personnel shall inspect each pipe joint immediately prior to installation to make sure there are no rodents or other undesirable items in the pipe. Pipe ends shall be capped and secured at the end of each day's work. Do not lay pipe when conditions of trench or weather prevent installation. Depth of cover over top of pipe shall be as indicated on the contract drawings.

501.3.1.4 Thrust Blocks: Concrete "thrust blocks" shall be provided at all pipe direction changes in excess of 11 1/4 degrees as detailed in the project drawings. Additional requirements for vertical direction changes are also contained in the project drawings. "Thrust Blocks" shall be Cast-In-Place Concrete per Section 301, poured against undisturbed trench banks to provide positive restraint for the water line, and include fittings at the operating pressure plus surge events.

501.3.1.5 Installation of Tracer Wire and Warning Tape: Install a continuous length of tracer wire for the full length of each run of pipe. Attach wire to bottom of pipe in such manner that it will not be displaced during construction operations. Splices shall be suitable for direct bury but shall be held to a minimum. Contractor shall provide apparatus as required for continuity verification after installation.

501.3.1.6 Connections to Existing Water Lines: Make connections to existing water lines after approval is obtained from the Engineer and with a minimum interruption of service on the existing line.

501.3.1.7 Flanged Pipe: Flanged pipe shall only be installed above ground or with the flanges in manways or vaults.

501.3.1.8 Installation of Valves and Hydrants:

501.3.1.8.1 Installation of Valves: Valves and valve boxes shall be installed plumb and to the depth specified on the project drainings with concrete support, as detailed on the project drawings. Make and assemble joints to gate valves and check valves as specified for making and assembling the same type joints between pipe and fittings.

501.3.1.8.2 Installation of Hydrants: Install hydrants in accordance with AWWA C600 for hydrant installation and as detailed. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings. Install hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two (2) paved adjacent surfaces, contact the Engineer for further instructions.

Fire hydrants shall be set to such depth as to provide cover for connecting pipe equal to the water main. The bottom flange of fire hydrants shall be above the finished grades as shown on the project drawings. The Contractor shall be responsible for providing fire hydrants of proper barrel lengths for job conditions. A minimum of eight (8) cubic feet of gravel backfill around the base of the hydrant shall be provided for disposing of water from the hydrant barrel. In some areas where drain-back will not be absorbed into surrounding soil, or where it will cause foundation problems, additional gravel pits and piping may be required.

501.3.1.8.3 Installation of Air Release and Vacuum Valves: Shall be installed at locations shown on the drawings. Pipe shall be laid to grade up to the valves. Extra pipe line depth may be required so that valves and appurtenances may be installed within the vaults.

501.3.2 SPECIAL REQUIREMENTS FOR INSTALLATION OF WATER MAINS

501.3.2.1 Installation of Ductile-Iron Piping: Unless otherwise specified, install pipe and fittings in accordance with Section 203 and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

501.3.2.1.1 Jointing: Make push-on joints with the gaskets and lubricant specified for type of joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly. Make restrained joints with the gaskets, glands, locking segments, bolts, and nuts specified for this type of joint; assemble in accordance with

the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11. Make flanged joints with the gaskets, bolts, and nuts specified for this type of joint. Make flanged joints up-tight and avoid undue strain on flanges, fittings, valves, and other [equipment and] accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes. The use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces shall be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange.

501.3.2.1.2 Allowable Deflection: The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

501.3.2.1.3 Polyethylene Encasement of Ductile Iron Pipe: Installation of two (2) layers of polyethylene encasement shall be in accordance with the provisions of methods A, B, and C, AWWA C105, the manufacturers recommendations, and with modifications as contained here-in.

I. Encasement material shall be clean and free of clay lumps, sand, rock, or any foreign material prior to placement. The trench bottom surface of granular material shall be accurately graded with depressions for bell holes. Trench shall be free of water.
II. Equipment used for lifting or inserting pipe shall be of a material that will not damage the encasement material. Chains are not permitted.
III. Layer 1 shall utilize tubular V-Bio polyethylene as described in methods A or B with required overlaps (min. 1 ft.) and taping of joints with polyethylene adhesive tape. Longitudinal tube overlaps shall be taped at the 1/4 points. Layer 1 shall be snug, free of loose, bunched up areas, closed, and taped prior to proceeding to Layer 2.
IV. Layer 2 shall utilize tubular sheet or polyethylene as described in Methods A, B, or C. Sheet encasement shall be in place on trench floor prior to lowering or partially lowering pipe with Layer 1 intact. Plastic shall be lapped along longitudinal dreams, at the top portion of pipe. Tubular encasement shall be installed over each layer as described in Step III. The Layer 2 end laps shall be staggered from Layer 1 end laps. Layer 2 shall be snug with taped joints.
V. Special shapes such as valves and fittings will require cutting and fitting plastic to conform to the shape of the item. Protrusions that may puncture the plastic to have foam or other material applied adjacent to or as a cover to decrease the protruding effect. Plastic around special shapes shall be well taped.
VI. The result of a repair of damaged encasement due to installation mishaps or a need to view portions of the installed pipeline, shall be a secure, 2 layer

system that is snug fitting and well taped. Mishaps that result in soil material accumulations between the plastic and pipe will require removing that portion of plastic and replacing with new (2 layers).

VII. Workmanship – Installation of the polyethylene 2-layer system is crucial to the life of the pipeline. Work personnel shall have been trained and/or shall be trained on this project for installation of the plastic system. The initial four (4) hours of continuous installation shall be in the presence of the Contractor, Contractor's foreperson, the Engineer, and his field personnel. The techniques used to enhance quality and production are to be refined during this period. Work personnel and laborers that are not trained shall not be allowed to work in the encasement operation.

VIII. Techniques for backfilling and compacting bedding material around encased pipe shall be such as not to disturb or damage the plastic.

501.3.2.2 Installation of PVC Plastic Water Main Pipe and Associated Fittings: Unless otherwise specified, install pipe and fittings in accordance with Paragraph 501.3.1. Adhere to the requirements of UBPPA UNI-B-3 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings. Follow the recommendations for pipe joint assembly and appurtenance installation detailed in AWWA M23.

501.3.2.2.1 Jointing: Make push-on joints with the elastomeric gaskets specified for this type of joint by using elastomeric-gasket bell-end pipe. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel. For push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of the pipe manufacturer. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of the pipe manufacturer and standard industry practices. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type of joint and assemble in accordance with standard industry practices. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer. Use internal stiffeners as previously specified for compression-type joints.

501.3.2.2.2 Offset: Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Engineer, but shall not exceed five (5) degrees.

501.3.2.2.3 Fittings: Install Fittings in accordance with AWWA C605.

501.3.2.3 Installation of Glass Reinforced Polymer Pipe (GRP): Glass Reinforced Polymer pipe shall conform to the requirements of AWWA C950 and ASTM D3517 for installation.

501.3.2.4 Installation of Polyethylene Pipe: Polyethylene pipe shall conform to the requirements of AWWA C901/C906 for installation.

501.3.3 INSTALLATION OF WATER SERVICE PIPING N/A

501.3.4 SPECIAL REQUIREMENTS FOR INSTALLATION OF WATER SERVICE PIPING

501.3.4.1 Installation of Plastic Piping: Install pipe and fittings in accordance with Paragraph 501.3.1 General Installation of Water Pipelines and with the applicable requirements of ASTM D 2774, unless otherwise specified.

501.3.4.1.1 Jointing: Make solvent-cemented joints for PVC plastic piping using the solvent cement previously specified for this material. Assemble joints in accordance with ASTM D 2855. Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

501.3.4.1.2 Plastic Pipe Connections to Appurtenances: Connect plastic pipe service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.

501.3.4.2 Location of Meters: Meters and meter boxes shall be installed at the locations shown on the drawings. The meters shall be centered in the boxes to allow for reading and ease of removal or maintenance.

501.3.5 TESTING OF PIPE LINES

Pipe lines (PVC, ductile, iron, and GRP) installed under this specification shall be tested in accordance with the following provisions before acceptance by the Owner and subsequent tie-ins. The completed piping system shall be filled with water and subjected to a hydrostatic pressure test.

For the hydrostatic pressure test, use a hydrostatic pressure of 150 percent greater than the maximum working pressure, the system anticipated maximum surge pressure, or 200 psi, whichever is greater. Hold this pressure for not less than two (2) hours at the low end of the test segment. Prior to the pressure test, fill that portion of the pipeline being tested with water and ensure all air within the line has been vacated. The Contractor shall be responsible for setting up all equipment for the test including flow meter, backflow preventer, and pressure pump and shall have the option of testing against the new system valves or against temporary

caps or plugs if valve leakage is suspected. Provisions shall be made for removing all air from the system.

Methods of conducting the pressure and leakage test shall be in accordance with provisions of AWWA Specification C600 provided that allowable line leakage shall be not more than the following:

$$\text{Leakage} = \text{NDP} \cdot {}^{5}/_{7400} \text{ gallons/hr}$$

From the above Equation, N is the number of joints, D is the pipe diameter in inches, and P is the test pressure in psi.

501.3.6 DISINFECTION OF WATER LINES

Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. All water mains installed under this project shall be disinfected, thoroughly flushed, and tested before being placed into service.

Chlorine solution shall be pumped into the line in a manner to prevent air entrapment in the line. The Contractor shall provide filling, sampling, flow meters, and air release taps as required. Liquid chlorine concentrate shall be used for chlorine solution. Powder chlorine concentrate will not be permitted. The amounts applied shall be pre-calculated so as to yield initial concentrations in the line of no less than 50 ppm. The detention period in the line shall be 24 hours. After the 24 hour detention period, the line shall be flushed until the residual chlorine concentration is approximately one (1) pmm or the residual chlorine content of domestic water supply, whichever is lower. The line shall then be left to set for 48 hours (full of water). After completion of the 48 hour period, samples shall be taken for bacteriological testing. Samples shall be taken from suitable locations (such as service taps) and placed into commercial sterilized containers furnished by the Contractor. Upon completion of a successful cold form test, the line may be put into service. Test results that indicate unacceptable coliform levels shall call for the repeat of the disinfection procedure until a successful coliform test is achieved.

A copy of the bacteriological (coliform) test results shall be delivered to the Project Engineer and the Owner prior to tie-ins.

501.3.7 FIELD QUALITY CONTROL

501.3.7.1 Field Tests and Inspections: Prior to hydrostatic testing, obtain Engineer approval of the proposed method for disposal of wastewater from hydrostatic testing. The Engineer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications. Do not

begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least five (5) days after placing of the concrete.

501.3.8 TIE-INS, MAINTAINING EXISTING SERVICE AND SCHEDULING OF WORK

The Contractor shall keep the Project Engineer and affected public informed as to when water outages are to be expected. The Contractor shall inform the public by radio, the newspaper, or by handouts and door to door contact, providing adequate lead time. Generally, the outages affecting small areas may be handled by informing residents in person.

All new water line construction shall be done while maintaining water service with the existing systems. If the Contractor is required to place the new main in or near the same locations as the existing main, because crowded conditions, the Contractor shall provide a temporary main lying on the ground and connect existing meters to maintain service during construction. The Contractor shall be required to arrange his construction schedule to maintain continuous service to water users for the fullest extent possible. Temporary mains shall be disinfected in a manner similar to new mains described above.

Tie-ins shall be thoroughly planned prior to beginning construction. The Contractor shall familiarize himself with pipe sizes and materials of the existing Owner's system. The Contractor shall have required adaptors, pipe, sleeves, pumps, tampers, water trucks, bolts, nuts, and other equipment and materials of the size to complete the tie-in, in as short a time as possible.

Reservoir valve replacement, if required, will require draining the vessel. This will require extensive planning and coordination with the Owner's Water Production personnel.

The Contractor shall coordinate all construction activities including tie-ins with the Owner's Water Department.

501.3.9 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

501.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be as set forth in the Special Conditions.

502 CONCRETE VAULTS AND MANWAYS - INDEX

502 CONCRETE VAULTS AND MANWAYS

502.1 GENERAL

502.1.1 DESCRIPTION

This item of work shall consist of furnishing all material, supplies, plant and labor required for the construction of concrete vaults, manways, and appurtenances complete in accordance with applicable provisions and the contract documents.

Concrete vaults and manways shall be of the size and type shown or required by job conditions and be built at the locations shown on the drawings or at a location designated by the Engineer.

502.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include but are not limited to the following:

I. Section 101, Submittal Procedures
II. Section 203, Trenching, Excavation and Backfilling
III. Section 204, Fill Materials
IV. Section 301, Cast-in-Place Concrete
V. Section 302, Concrete Formwork
VI. Section 501, Waterlines and Appurtenances
VII. Section 503, Station Valves, Piping, and Appurtenances, & Associated Painting

502.1.3 SUBMITTALS

Engineer approval is required for all submittals. The following shall be submitted in accordance with Section 101.

I. Frame and cover that shall be used with associated weights
II. Liner type including embedment technique
III. Coating material, supplies, application method, and factory testing results
IV. Certificate for applicators
V. Shop drawings of precast concrete vaults and manways

502.2 MATERIALS

502.2.1 CONCRETE VAULTS AND MANWAYS MATERIAL

Concrete vaults and manways shall be constructed of precast units when called for in the contract documents. Precast riser sections, transition top sections, flat slab tops, and grade rings shall be manufactured in accordance with ASTM C478. The bottom slab thickness shall

be a minimum of six (6) inches or as designated on the project drawings. The top section shall be flat reinforced slab lids with an access hatch or manway frame and cover as designated on the project documents. The flat top lids shall be H-20 rated and furnished with provisions to remove lid by lifting. All joints between riser sections shall be tongue and grooved. Precast base sections shall be formed with floor penetrations to accommodate the gravel drain when called for on the project drawings.

Cast-in-place reinforced concrete vaults and manways shall be as designated on the project drawings and shall adhere to Sections 301 and 302.

The Contractor may elect to place a ready mix concrete base and set the first riser in lieu of having a precast base. Placed concrete shall be a minimum 12 inches thick with dimensions equal to the riser section's exterior geometry or outside diameter with an additional six (6) inches.

502.2.2 ACCESS HATCHES AND COVERS

502.2.2.1 Manway Frame and Cover: Manway frames and covers shall be traffic grade cast iron conforming to ASTM A48 36C, Class 30, and shall have no vent holes of any kind. Manway covers shall have a suitable pattern, recessed lifting bars, and the appropriate word for the utility cast in three (3) inch letters. The frame shall be cast-in flat reinforced slab lid or as detailed on the project drawings.

502.2.2.1.1 Manufacturer: Manway covers shall be Neenah Foundry or an approved equal.

502.2.2.2 Aluminum Access Hatches: Aluminum access hatches shall have special aluminum or stainless-steel lids with hinged opening(s), a hold open feature, and a fall protection feature. The locking mechanism shall be provided when designated on the project drawings. Hinged doors of the dimensions shown on the project drawings shall be Halliday or an approved equal rated for H-20 loading.

502.2.3 SEAL TONGUE AND GROOVE JOINT

502.2.3.1 Jointing Precast Riser Sections: Seal all tongue and groove joints of precast riser sections with a preformed flexible sealant or a rubber O-ring gasket (on circular riser sections). Rubber gasket(s) shall conform to ASTM C443.

502.2.3.1.1 Preformed Flexible Sealants: Preformed flexible sealants shall be Ram Nek as manufactured by K.T. Snyder Company or an approved equal.

502.2.4 STEP RUNGS

If no materials are so described on the project drawings the following shall apply:

Step rungs shall be aluminum, steel reinforced polyethylene, or steel reinforced copolymer polypropylene. Steel reinforced copolymer polypropylene shall be 16 inches wide as manufactured by M.A. Industries, Inc., P.F. Series or an approved equal.

502.2.4.1 Cast Aluminum: Cast aluminum shall be an aluminum alloy 6061-T6 and have a drop front design, 16 inches wide with an abrasive step surface.

503.2.4.2 Grout: The grout used to fill the space around the rung penetrations shall be a non-shrink grout.

503.2.4.3 Steel Reinforcement: Steel reinforcement shall be Grade 60 and continuous throughout the rung.

502.2.5 PIPE CONNECTIONS TO VAULTS AND MANWAYS

Pipe connections to vaults and manways shall be as described on the project drawings. If no materials are so described on the project drawings, the following shall apply:

502.2.5.1 Tight-Fitting Neoprene Gasket: The Contractor shall provide a tight-fitting neoprene gasket.

502.2.5.2 Grout: Grout shall be non-shrink and water proof as manufactured by Embeco, Waterplug, or an approved equal.

502.2.6 EXTERIOR VAULT AND MANWAY COATINGS

The exterior vault and manway coating shall be NSF potable water approved, ASTM D4479 Type I, bituminous material damp proofing. The coatings shall be Henry HE794 or an approved equal.

502.3 EXECUTION

502.3.1 CONSTRUCTION

502.3.1.1 Concrete Vault and Manway Bases: Concrete vault and manway bases shall be constructed on firm, compacted, or neat cut subgrade. After the base is placed, the material from the gravel drain area shall be removed and gravel shall be placed as required. Cut holes in precast barrel sections for pipe penetrations prior to setting sections in place to prevent jarring and loosening or mortar joints. Precast sections shall be plumb with a 1/4 inch out of plumb tolerance. Seal joints with either a rubber O-ring or preformed flexible joint sealant. Finish joints shall be filled with non-shrink grout and finished flush with the adjoining surfaces. All other penetrations shall be finished flush with non-shrink grout and/or silicon seal.

For cast in place bases, concrete shall be poured on firm, compacted or neat cut ground with a minimum thickness of eight (8) inches or as detailed on the project drawings. The

cast-in-place concrete base shall have a tongue and groove depressed in the concrete for the riser sections to sit on and formed gravel drain penetrations.

502.3.1.2 Access Hatches: Access hatches and covers shall be cast in a flat top lid unless otherwise called for on the project drawings. Utilize precast concrete grade rings, 12 inches maximum, to ensure frame and cover are set to the finished grade. Frame and cover shall be set and held in place with a reinforced concrete collar, as shown on the contract drawings, prior to placement of permanent paving.

502.3.1.3 Step Rungs: Step rungs shall only be installed if specifically called for on the project drawings and, if called for, shall be installed as shown on the project drawings and/or in accordance with this Section.

Step rungs shall be installed by grouting rungs into preformed holes in riser and cone sections and shall have 12 inch centers. Holes shall be 1 1/8 inches in diameter and be a minimum of 3 1/2 inches deep. The space around the rung penetrations shall be filled with a non-shrink grout. The Contractor may drill holes for rungs to accommodate field conditions when approved by the Engineer. All rung installation methods shall withstand a pull-out resistance of 1500 pounds.

502.3.2 PIPE CONNECTION TO VAULT OR MANWAY

502.3.2.1 Connection to Existing Vault or Manway: Pipe connections to existing vaults or manways shall be made so finished work will conform as nearly as practicable to the applicable requirements specified for new vaults or manways, including all necessary concrete work, cutting, and shaping. The connections shall be centered on the vaults or manways. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no longer than 1 1/2 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

502.3.2.2 Connection to Vault or Manway: A tight-fitting neoprene gasket shall be placed on the pipe where it will center in the vault or manway wall to prevent seepage along the pipe. The pipe shall then be grouted in place.

502.3.3 EXTERIOR VAULT AND MANWAY COATING APPLICATION

The manufacturer's recommendations shall be followed for surface preparation and damp proof application. Protective equipment, clothing and respirator requirements must be followed according to the product's MSDS.

The exterior vault and manway shall receive two (2) coats of NSF potable water approved, ASTM D4479 Type I, bituminous material damp proofing. The material shall be applied after grouting of horizontal joints and areas around penetrations.

502.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be as set forth in the Special Conditions.

503 STATION VALVES, PIPING, APPURTENANCES, AND ASSOCIATED PAINTING - INDEX

503 STATION VALVES, PIPING, APPURTENANCES, AND ASSOCIATED PAINTING

503.1 GENERAL

503.1.1 DESCRIPTION

The Contractor shall provide all labor, materials, plant, equipment and incidentals required to furnish and install all valves, piping and appurtenances for the station. Pipe, valve and pump painting is included with this Section. The work includes, but is not necessarily limited to, all types of valves required for buried and exposed piping.

503.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include but are not limited to the following:

I. Section 201, General Earthwork
II. Section 202, Clearing and Grubbing
III. Section 203, Trenching, Excavation, and Backfilling
IV. Section 301, Cast-In-Place Concrete
V. Section 302, Concrete Formwork
VI. Section 304, Curb & Gutter, Sidewalks, Drive Pad and Concrete Pavement Construction
VII. Section 501, Waterlines and Appurtenances
VIII. Section 701, Station Buildings
IX. Section 16000, Electrical

503.1.3 SUBMITTALS

503.1.3.1 Manufacturer's Qualifications: The manufacturer shall have a minimum of five (5) years of experience in the production of substantially similar equipment and shall show evidence of satisfactory service for at least five (5) installations.

Each type of pipe, fitting, and valve shall be the product of one manufacturer.

503.1.3.2 Shop Drawings: Submit the following for approval in accordance with Section 101.

I. Manufacturer's literature, illustrations, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances
II. Deviations from the project drawings and Specifications
III. Engineering data including dimensions, materials, size and weight
IV. Fabrication, assembly, and installation diagrams

503.1.3.3 Operation and Maintenance Data: Submit complete manuals including the items listed below:

I. Copies of all shop drawings
II. Test reports, maintenance data and schedules
III. Description of operation
IV. Spare parts information

503.1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

Handle all valves, piping and appurtenances very carefully. Cracked, dented or otherwise damaged or dropped valves shall not be accepted. Any damaged pipe will not be accepted as well. Store materials to permit easy access for inspection and identification. Keep steel members off the ground using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration. Store all mechanical equipment in covered storage off the ground and prevent condensation.

503.2 MATERIALS

503.2.1 GENERAL

The Contractor shall verify all materials conform to the requirements of the Contract Documents. All materials incorporated in the work shall be NSF 61 approved, new and unused, of the quality specified herein and shall be installed in accordance with the recommendations of the manufacturer.

It is required that a factory trained technician be on hand at the system start up to instruct Owner personnel on proper pilot valve adjustments and settings on hydraulically controlled valves. The Contractor shall coordinate with the Owner, Engineer and factory trained technician to complete this task.

503.2.1.1 Valves: Valves shall have the manufacturer's name and working pressure cast in raised letters on the valve body. Manual valve operators shall turn clockwise to close unless otherwise specified. Valves shall indicate the direction of operation.

503.2.1.2 Bolts, Nuts and Studs: All bolts, nuts, and studs on or required to connect buried valves shall be Type 304 stainless steel. All bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A307, Grade B; or ASTM A354.

503.2.1.3 Gaskets: Gasket material shall be of the type recommended by the valve manufacturer and other appurtenances for installation.

503.2.2 BALL VALVES 1/2 INCH TO TWO (2) INCHES IN DIAMETER

When ball valves are called for in the contract documents, they shall be steel body with stainless steel bore ball as Jamesbury Valve – Line or an approved equal.

503.2.3 RESILIENT WEDGE GATE VALVES TWO (2) INCHES IN DIAMETER AND LARGER

Resilient wedge gate valves shall be of iron body, bronze mounted, non-rising stem and in conformance with AWWA C509 or C515.

503.2.3.1 Sealing Mechanism: The sealing mechanism shall consist of a cast iron or ductile iron gate with a resilient wedge that is bonded or mechanically attached. It shall be designed to seal when unbalanced-balanced pressure is applied to either side of the gate. The sealing mechanism shall not allow any leakage at 250 psi or less working pressure with line flow in either direction.

503.2.3.2 Valves and Valve Operator: Valves shall be furnished with an epoxy coating conforming to Paragraph 503.2.17. The valve operator shall be a handwheel and clockwise to close for exposed valves.

503.2.3.2.1 Station Valves: Station valves shall be flanged except where designated otherwise on the project drawings.

503.2.3.2.2 Buried Valves: Buried valves shall be equipped with a two (2) inch operating nut and a two (2) piece valve box and cover that adhere to Section 501.

503.2.3.3 Manufacturer: Provide gate valves of Mueller Company, Clow Company, or an approved equal.

503.2.5 PRESSURE REDUCING VALVES 2 1/2 INCHES AND SMALLER

503.2.5.1 Valve: The valve body and cover shall be Bronze ASTM B-62. The valve shall be rated for a minimum of 250 psi working pressure and the main valve trim shall be 416 Stainless Steel.

503.2.5.2 Strainer: The strainer shall be Stainless Steel, Type 416.

503.2.5.3 Manufacturer: The Contractor shall provide a 90 psi pressure reducing valve manufactured by Cla-Val Co. or an approved equal with adjusting wrenches and dual union tailpieces (NPT Threaded). The adjustment range shall be 87 to 145 psi.

503.2.6 TWO INCH AND SMALLER PIPE FASTENING SYSTEM

Piping mounts and supports shall be provided to securely fasten two (2) inches and smaller piping to the interior walls of the station. All hardware used shall be pre-painted or stainless steel.

503.2.6.1 Manufacturer: The Contractor shall provide Cush-A-Clamp by Unistruct or an approved equal.

503.2.9 PRESSURE RELIEF/PRESSURE SUSTAINING VALVE

The pressure relief/pressure sustaining valve shall be a hydraulically operated and pilot controlled valve that is designed to relieve pressure at an adjustable set point in the event of a closed system. The valve body and cover shall be Ductile ASTM A536 and have connections as called for on project design drawings. The valve shall be rated for a minimum 250 psi working pressure, be hydraulically operated, and be pilot controlled. The main valve trim shall be Bronze ASTM B-62.

503.2.9.1 Pilot: The pilot control shall be Bronze ASTM B-62 and the pilot trim shall be Stainless Steel, Type 303.

503.2.9.2 Manufacturer: The manufacturer shall be Cla-Val Co. or an approved equal. The desired model is Model 50-01.

503.2.9.3 Coatings: Interior and exterior coatings shall be epoxy coated per Paragraph 503.2.17.

503.2.9.4 Pressure Range: The pressure range shall be between 20-200 psi.

503.2.9.5 Options: The options shall include a CK2 Isolation Valve(s), a X141 pressure gauge, a X101 valve position indicator, and a check valve with an isolation valve.

503.2.9.6 Limit Switch: A limit switch shall be provided to begin pump shutdown sequence when the valve is opened due to high pressure.

503.2.10 VACUUM AIR RELEASE VALVE

Air release valves and combination air valves (Single Body Type and Dual Body Type) shall be referenced to Section 501.

503.2.11 MAGNETIC FLOW METER

The meters shall be electromagnetic flow type meters as called for, based on Faraday's law of induction, and accurate to ± one (1) percent of flow. The meter shall be National Sanitation Foundation (NSF) approved for potable drinking water, rated for 250 psi pressure, and have flanged connections. The meter shall include a remote display/amplifier with a signal processor with four (4) programmable digital outputs and two (2) analog outputs for the SCADA system. The display shall have a large, eight-line LCD remote display with backlight. Meter liner shall be NSF approved fusion bonded epoxy. Meters shall be Elster Evo Q4 meter with appurtenances for 4-20 mA digital pulse outputs and cable as required or an approved equal.

503.2.12 MISCELLANEOUS VALVES FOR POTABLE AND PROCESS SYSTEMS

Provide the following valves as required for potable and process systems:

I. Ball valves
II. Hose bibs
III. Needle valves
IV. Check valve

503.2.12.1 Body: Valves for potable and process systems shall have Red Bronze ASTM B-584 Alloy 845 bodies and threaded ends.

503.2.12.2 Pressure Rating: The pressure rating shall be 250 psi.

503.2.12.3 Seats: The seats shall be TFE for resilient seating.

503.2.12.4 Ball and Needle Valves: The ball and needle valves shall have a stainless steel ball or needle and stems.

503.2.13 PRESSURE GAGES

Pressure gages shall have a white face with black numerals enclosed in a flangeless aluminum case. Gages shall be accurate to one (1) percent of scale and shall be installed with an on - off valve (ball type). Gages shall be glycerin or mineral oil filled and shall have 3 1/2 inch diameter cases. Ranges shall be as shown, or if not shown, as selected by Engineer

503.2.13.1 Manufacturer: The pressure gages shall be Helicoid Series 900 by Bristol Babcock, or an approved equal.

503.2.14 DUCTILE IRON PIPE AND FITTINGS

503.2.14.1 Flanged Pipe 16 Inches and Smaller: Flanged pipe 16 inches and smaller shall be Class 350 fabricated in accordance with AWWA C115.

503.2.14.2 Flanged Pipe 18 Inches and Larger: Flanged pipe 18 inches and larger shall be Class 250 fabricated in accordance with AWWA C115.

503.2.14.3 Flanged Fittings: Flanged fittings shall conform to AWWA C110.

503.2.14.4 Flange Gaskets: Flanged gaskets shall be 1/8 inch minimum thick, full faced rubber, and conform to AWWA C111.

503.2.14.5 Coating: Coatings shall conform to Paragraph 503.2.17.

503.2.15 STEEL PIPE

Steel pipe used shall be ASTM A53 furnished with threaded ends, beveled ends (for welding) or plain ends.

503.2.15.1 Fittings: Fittings shall be fabricated of the same material as the pipe line of which they are a part.

503.2.15.2 Galvanized Steel Pipe: Galvanized steel pipe shall conform to ASTM A120.

503.2.15.3 Coatings: Coating shall conform to Paragraph 503.2.17.

503.2.16 COPPER PIPE

Copper pipe and solder joints shall be used where designated. Copper piping shall be Type K hard temper with solder joint pressure fittings. Type K copper pipe shall conform to ASTM B88. Fittings shall conform to ANSI B16.22.

503.2.16.1 Connections: All connections at valves shall be threaded with joint compound or Teflon tape.

503.2.17 PAINTING

Contractor shall provide all labor, materials, equipment and incidentals as required to paint and finish piping, fittings, and appurtenances as listed below unless otherwise noted on the project drawings. Painting and finishing includes all coating materials, pretreatments, surface preparation, primers, sealers, and finish coats.

503.2.17.1 Factory Coated Valves, Meters and Specials: Items that are factory coated shall have a three-coat epoxy coating or a single coat fusion bonded epoxy system with minimum dry film thickness (DFT) of 10 mils. The coatings shall be touched up using factory supplied touch-up paint and materials. Touch up work shall be done according to the manufacturer's recommendations. The coating system shall meet AWWA C550 and be approved by NSF-61.

503.2.17.2 Ductile Iron Pipe and Fittings:

503.2.17.2.1 Interior Lining and Coating: The interior lining and coating shall be Cement-Mortar Lining with asphaltic coating and shall conform to ANSI/AWWA C104/A21.4.

503.1.17.2.2 Exterior Coating:

I. Option A
   i. The exterior pipe surface shall be cleaned and prepped to meet the manufacturer's recommendations
      A. Surface preparation may be completed at the factory
   ii. Primer shall be factory applied

iii. Apply lead and chromate free red phenolic alkyd primer, Tnemec Series 37h – Chem-Prime HS or an approved equal to 2.5 to 3.5 mils DFT
iv. Apply two (2) coats of alkyd paint, Tnemec Series 2H – Hi-Build Tnemec Gloss or an approved equal to 2.5 to 3.5 mils DFT per coat
A. Color shall be selected by the Owner

II. Option B
i. Clean and prep exterior pipe surface to meet the primer manufacturer's recommendations
ii. Surface preparation may be completed at the factory
iii. Primer shall be factory applied
iv. Apply lead and chromate free red phenolic alkyd primer, Tnemec Series 37h – Chem-Prime HS or an approved equal to 2.5 to 3.5 mils DFT
v. Apply two (2) coats of epoxy paint, Tnemec Series 66 – Hi-Build Epoxoline or an approved equal to 2.5 to 3.5 mils DFT per coat
A. Color shall be selected by the Owner

503.2.17.3 Steel Pipe and Fittings:

503.2.17.3.1 Interior Coating:

I. Surface preparation shall be by commercial blast cleaned complying with SSPC-SP10
II. Surface preparation may be completed at the factory or fabrication shop
III. Primer may be factory or shop applied
IV. Apply NSF 61 approved zinc rich primer, Tnemec Series 91 – H20 Hydro-Zinc Primer or an approved equal to 2.5 to 3.5 mils DFT
V. Apply two (2) coats of NSF 61 approved epoxy paint, Tnemec Series N140 – Pota-Pox Plus or an approved equal 4 mils DFT per coat
i. Coating may be factory or shop applied
VI. The coatings shall be touched up using factory supplied touch-up paint and materials
i. Touch up work shall be done according to the manufacturer's recommendations

503.2.17.3.2 Exterior Coating:

I. Surface preparation shall be by commercial blast cleaned complying with SSPC-SP10
II. Surface preparation shall be completed at the factory or fabrication shop
i. Option A
A. Apply NSF 61 approved zinc rich primer, Tnemec Series 91 - H20 Hydro-Zinc Primer or an approved equal to 2.5 to 3.5 mils DFT
B. Primer shall be factory or shop applied
C. Apply two (2) coats of NSF 61 approved epoxy paint, Tnemec Series N140 – Pota-Pox Plus or an approved equal to 3 to 4 mils DFT per coat

a. Coating may be factory or shop applied
b. Color shall be selected by the Owner

D. The coatings shall be touched up using factory supplied touch-up paint and materials.
a. Touch up work shall be done according to the manufacturer's recommendations.

ii. Option B
A. Apply a fusion bonded epoxy to 6 to 8 mils DFT

503.3 EXECUTION

503.3.1 GENERAL PIPE INSTALLATION

General pipe installation shall be completed in accordance with Section 203 and Section 501 of these Specifications.

503.3.2 INSTALLATION OF ABOVE GRADE FLANGED PIPING

Provide pipe hangers and supports as detailed on the project drawings and install the pipe without springing, forcing, or stressing the pipe, any adjacent connecting valves, and equipment.

Flanged pipe through manways and vaults shall utilize full pipe joints on all entrance and exits from the structure. The pipe shall be supported by properly bedding and backfilling the portion of pipe outside of the structure.

The pipe shall be set with the flange bolt holes straddling the pipes' horizontal and vertical centerline. Install the pipe without springing, forcing, or stressing the pipe, any adjacent connecting valves and equipment. Before bolting up, align flange faces to the design plane within 1/16 inch per foot (measured across any diameter). Align the flange bolt holes within 1/8 inch maximum offset. Align the flange bolt holes on floor and/or wall penetrations to meet the above design plane specification utilizing a "Two Hole" or other approved method to ensure pumps, valves, and/or fittings are installed in horizontal or vertical position as shown on the project drawings.

Clean bolts, nuts, washers and flange faces by wire brushing before installing the gasket and adjoining flange. Inspect the gasket seating surfaces, gasket, each bolt, nut, washer, and facing on which the nuts will rotate. Replace any damaged item. Lubricate threads of carbon steel and/or stainless-steel bolts and nuts with oil and graphite prior to installation. Assemble all bolts, nuts, and washers in the flange, then tighten nuts in a progressive diametrically opposite sequence, and torque with a calibrated torque wrench. All clamping torque shall be applied to the nuts only. Bolt lengths shall extend completely through their nuts. Any which fail to do so shall not be considered acceptably engaged. Place washers under all nuts. Place washers under bolt heads where the flanges have been fusion bonded epoxy coated. Do not damage coated surfaces during installation.

Do not use more than one gasket between contact faces in assembling a flanged joint. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reset or replace the

gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight. Replace galled, cracked, or distorted bolts and nuts.

Wrap buried pipe and flanges which connect to buried valves or other buried equipment with two layers of polyethylene encasement as specified per Section 501. Extend the polyethylene material over the flanges and bolts and secure it around the adjacent pipe circumference with plastic adhesive tape.

Where outlets are not indicated to be connected to valves or other pipes, complete the installed pipeline pressure test by providing blind flanges with bolts, nuts, washers, and gaskets.

503.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be set forth in the Special Conditions.

505VC VERTICAL CENTRIFUGAL PUMP SKIDS– INDEX

505VC VERTICAL CENTRIFUGAL PUMP SKIDS

505VC.1 GENERAL

505VC.1.1 DESCRIPTION

The Contractor shall furnish all labor, materials, equipment, and incidentals required to install a completely operational vertical centrifugal pump skid or unit as specified herein and shown on the contract drawings. Note all requirements below.

The term “pump skids” shall be defined as a pump complete with base plate, companion flanges, discharge headers, motor and control panel with base plate.

Vertical centrifugal pump skid units may be single, duplex, or triplex arrangement. Pump controls will alternate starts between pumps and skids will have built-in pressure tanks or relief valves to prevent or cushion water hammer.

The pump manufacturer shall be responsible for supplying the complete pumping unit as defined above and shall assume complete system responsibility.

Refer to drawings for general construction and specific electrical details.

505VC.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections include:

I. Section 101, Submittal Procedures
II. Section 501, Water Lines and Appurtenances
III. Section 16000, Electrical – General
IV. Section 16701, Sensing and Control Equipment
V. Section 16702, SCADA System

505VC.1.3 REFERENCE SPECIFICATIONS

Reference standards shall comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

I. Standards of the Hydraulic Institute
II. National Electric Code
III. Standards of National Electrical Manufacturers Association
IV. Institute of Electrical and Electronic Engineers
V. American National Standards Institute

VI. Standards of American Water Works Association
VII. American Society for Testing and Materials
VIII. International Standards Organization
IX. Underwriters Laboratories, Inc.

505VC.1.4 SUBMITTALS

Submit for approval the following:

505VC.1.4.1 Manufacturer's Literature, Illustrations, Specifications, and Engineering Data: Contractor shall submit items and include dimensions, materials, size, weight, performance data, and curves showing overall pump efficiencies, flow rate, head, brake horsepower, motor horsepower, speed and shut-off head. Pump characteristic curves showing pump capacity in gpm, net positive suction head (NPSH), head, efficiency and pumping horsepower. A complete list of equipment and material, including manufacturer's description data and technical literature, performance charts and curves, catalog cuts and installation instructions.

505VC.1.4.2 Shop Drawings: Shop drawings shall show fabrication, assembly, installation and wiring diagrams. Drawings shall contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage or equipment and appurtenances, clearances for maintenance and operations.

505VC.1.4.3 Operation and Maintenance Manuals: Copies of proposed operation and maintenance manuals to be submitted for approval, two copies to be returned with required changes noted prior to final submittal.

505VC.1.4.4 Lab Test Results: Performance test reports showing all lab tests performed to prove compliance with the specified criteria shall be submitted to the Engineer.

505VC.1.4.5 Operation and Maintenance Data: Five (5) copies of operation and five (5) copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system start up, operation and shut down. Operation manuals shall include the manufacturer's name, model number, parts list, and a brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to acceptance.

505VC.1.4.6 Manufacturer: BoosterpaQ Hyrdo MPC 3CR45-3-2 by Grundfos or equal.

505VC.2 MATERIALS

505VC.2.1 PUMPING UNITS

The pumping units provided under this Section shall be supplied by one manufacturer.

Each pumping unit shall be provided with a stainless-steel nameplate, which shall contain the following information:

I. Manufacturer's name, address, and telephone number
II. Model number
III. Serial number
IV. Head, capacity and rpm at rated condition
V. Motor horsepower, rpm and frame size

Pumping units within each type of service shall be identical in every respect with all parts being interchangeable except for rotation.

Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure.

The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer.

The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.

The complete packaged pumping system shall be NSF61 Annex G listed for drinking water and low lead requirements.

505VC.2.1.1 Pump Rotation Assemblies: Pump rotating assemblies shall be balanced in accordance with the requirements of ANSI S2.19, G6.3.

505VC.2.1.2 Vibration: Vibration, when measured at the pump bearing housing shall not exceed the limitations specified by the Hydraulic Institute Standards.

505VC.2.2 PUMPS

Pump skid shall be steel and stainless steel AISI 304.

TABLE 1: PUMP BOWL PERFORMANCE REQUIREMENTS AT 3600 RPM

PUMP No. 1, PUMP No. 2, & PUMP No. 3				
PUMP NO.	**FLOW RATE (GPM)**	**TDH (feet)**	**Minimum Efficiency (%)**	**Maximum Horse Power (hp)**
1	285	400	73.3	38
2	285	400	73.3	38
3	285	400	73.3	38
TOTAL	850	400	73.3	117

Points (1) and (3) to be within 3% of values listed. Max hp not to be exceeded at any point on the curve. Provide Total Dynamic Head and flow rate when 2 or more pumps are on in series.

Pumps shall operate in parallel when multiple pumps are started.

All pumps shall be ANSI/NSF 61 Annex G listed for drinking water and low lead requirements.

The pumps shall be of the in-line vertical multi-stage design.

The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

Small Vertical In-Line Multi-Stage Pumps (Nominal flow from 3 to 125 gallons per minute) shall have the following features:

1. The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.

2. The suction/discharge base shall have ANSI Class 250 flange or internal pipe thread (NPT) connections as determined by the pump station manufacturer.

3. Pump Construction.

   a. Suction/discharge base, pump head, motor stool: Cast iron (Class 30)
   b. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel

c.	Shaft	316 or 431 Stainless Steel
d.	Impeller wear rings:	304 Stainless Steel
e.	Shaft journals and chamber bearings:	Silicon Carbide
f.	O-rings:	EPDM

Shaft couplings for motor flange sizes 184TC and smaller shall be made of cast iron or sintered steel. Shaft couplings for motor flange sizes larger than 184TC shall be made of ductile iron (ASTM 60-40-18).

Optional materials for the suction/discharge base and pump head shall be cast 316 stainless steel (ASTM CF-8M) resulting in all wetted parts of stainless steel.

4. The shaft seal shall be a balanced o-ring cartridge type with the following features:

a.	Collar, Drivers, Spring:	316 Stainless Steel
b.	Shaft Sleeve, Gland Plate:	316 Stainless Steel
c.	Stationary Ring:	Silicon Carbide
d.	Rotating Ring:	Silicon Carbide
e.	O-rings:	EPDM

The Silicon Carbide shall be imbedded with graphite.

5. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft coupling and motor. The entire cartridge shaft seal shall be removable as a one piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

E. Large In-line Vertical Multi-Stage Pumps (Nominal flows from 130 to 500 gallons per minute) shall have the following features:

1. The pump impellers shall be secured directly to the smooth pump shaft by means of a split cone and nut design.

2. The suction/discharge base shall have ANSI Class 125 or Class 250 flange connections in a slip ring (rotating flange) design as indicated in the drawings or pump schedule.

3. Pump Construction.

a.	Suction/discharge base, pump head	Ductile Iron (ASTM 65-45-12)

b. Shaft couplings, flange rings: Ductile Iron (ASTM 65-45-12)
c. Shaft 431 Stainless Steel
d. Motor Stool Cast Iron (ASTM Class 30)
e. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
f. Impeller wear rings: 304 Stainless Steel
g. Intermediate Bearing Journals: Tungsten Carbide
h. Intermediate Chamber Bearings: Leadless Tin Bronze
i. Chamber Bushings: Graphite Filled PTFE
j. O-rings: EPDM

4. The shaft seal shall be a single balanced metal bellows cartridge with the following construction:

a. Bellows: 904L Stainless Steel
b. Shaft Sleeve, Gland Plate, Drive Collar: 316 Stainless Steel
c. Stationary Ring: Carbon
d. Rotating Ring: Tungsten Carbide
e. O-rings: EPDM

5. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover. The entire cartridge shaft seal shall be removable as a one piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

505VC.2.3 VARIABLE FREQUENCY DRIVES (PANEL MOUNT)

The VFD shall convert incoming fixed frequency single-phase or three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC induction motors. The VFD shall be a six-pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.

The VFD shall include a full-wave diode bridge rectifier and maintain a displacement power factor of near unity regardless of speed and load.

The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.

The VFD shall utilize an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. VFD's that utilize Sine-Coded PWM or Look-up tables shall not be acceptable.
VFD shall automatically boost power factor at lower speeds.

The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.

An empty pipe fill mode shall be available to fill an empty pipe in a short period of time, and then revert to the PID controller for stable operation.

Switching of the input power to the VFD shall be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.

Switching of power on the output side between the VFD and the motor shall be possible with no limitation or damage to the VFD and shall require no additional interlocks.

The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.

VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to -15% of the rated input voltage.

The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. VFD's without a DC link reactor shall provide a 5% impedance line side reactor.

VFD to be provided with the following protective features:

1. VFD shall have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.

2. VFD shall include circuitry to detect phase imbalance and phase loss on the input side of the VFD.

3. VFD shall include current sensors on all three-output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

4. VFD shall auto-derate the output voltage and frequency to the motor in the presence of sustained ambient temperatures higher than the normal operating range, so as not to trip on an inverter temperature fault. The use of this feature shall be user-selectable and a warning will be exported during the event. Function shall reduce switching frequency before reducing motor speed.

5. VFD shall auto-derate the output frequency by limiting the output current before allowing the VFD to trip on overload. Speed can be reduced, but not stopped.

6. The VFD shall have the option of an integral RFI filter. VFD enclosures shall be made of metal to minimize RFI and provide immunity.

VFD to be provided with the following interface features:

1. VFD shall provide an alphanumeric backlit display keypad, which may be remotely mounted using standard 9-pin cable. VFD may be operated with keypad disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.

2. VFD shall display all faults in plain text; VFD's, which can display only fault codes, are not acceptable.

3. All VFD's shall be of the same series, and shall utilize a common control card and LCP (keypad/display unit) throughout the rating range. The control cards and keypads shall be interchangeable through the entire range of drives used on the project.

4. VFD keypad shall be capable of storing drive parameter values in non-volatile RAM uploaded to it from the VFD, and shall be capable of downloading stored values to the VFD to facilitate programming of multiple drives in similar applications, or as a means of backing up the programmed parameters.

5. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

6. A start guide menu with factory preset typical parameters shall be provided on the VFD to facilitate commissioning.

7. VFD shall provide full galvanic isolation with suitable potential separation from the power sources (control, signal, and power circuitry within the drive) to ensure compliance with PELV requirements and to protect PLC's and other connected equipment from power surges and spikes.

8. All inputs and outputs shall be optically isolated. Isolation boards between the VFD and external control devices shall not be required.

9. There shall be three programmable digital inputs for interfacing with the systems external control and safety interlock circuitry. An additional digital input is preprogrammed for start/stop.

10. The VFD shall have two analog signal inputs. One dedicated for sensor input and one for external set point input.

11. One programmable analog output shall be provided for indication of a drive status.

12. The VFD shall provide two user programmable relays with selectable functions. Two form 'C' 230VAC/2A rated dry contact relay outputs shall be provided.

13. The VFD shall store in memory the last 5 faults with time stamp and recorded data.

14. The VFD shall be equipped with a standard RS-485 serial communications port for communication to the multi-pump controller. The bus communication protocol for the VFD shall be the same as the controller protocol.

VFD service conditions:

1. Ambient temperature operating range, -10 to 45ºC (14 to 113 □F).

2. 0 to 95% relative humidity, non-condensing.

3. Elevation to 1000 meters (3,300 feet) without derating.

4. VFD's shall be rated for line voltage of 525 to 690VAC, 380 to 480VAC, or 200 to 240VAC; with +10% to -15% variations. Line frequency variation of ± 2% shall be acceptable.

5. No side clearance shall be required for cooling of the units.

505VC.2.4 FIXED SPEED MOTORS

Fixed Speed Motors are to be provided with the following basic features:

1. Designed for continuous duty operation, NEMA design B with a 1.15 service factor.

2. Totally Enclosed Fan Cooled or Open Drip Proof with Class F insulation.

506B HYDROPNEUMATIC BLADDER SURGE CONTROL SYSTEM – INDEX

506B HYDROPNEUMATIC BLADDER SURGE CONTROL SYSTEM

506B.1 GENERAL

506B.1.1 DESCRIPTION

This Section describes the requirements for a hydropneumatic bladder surge control system. The purpose of the system is to minimize transient pressures from shock waves due to pump shutdown and startup.

506B.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include but are not limited to the following:

I. Section 101, Submittal Procedures

506B.1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

506B.1.3.1 Pressure Vessels: Pressure vessels shall be in accordance with the latest revision of the American Society of Mechanical Engineers (ASME) Code for the Unfired Pressure Vessels, Section VIII, Division 1.

506B.1.3.2 Plumbing Codes: All local plumbing codes shall be met.

506B.1.3.3 International Building Code: The system and anchorage of the surge tanks shall conform to the International Building Code (IBC).

506B.1.3.4 National Electric Code: The National Electric Code (NEC) shall be used for all wiring.

506B.1.4 SUBMITTALS

Submittals shall be in accordance with Section 101 of these project specifications and must include:

I. Detailed surge tank fabrication drawings
II. System assembly
III. Installation drawings
IV. Specifications for system components, accessories, and protective coatings

506B.1.4.1 Operation and Maintenance Manual: The Contractor shall submit five (5) copies of the operation and maintenance manual for approval. The manual shall include instructions on installation, operation and maintenance of the supplied components. A copy of ASME Pressure Vessel Code Form U-1A shall be included.

506B.1.5 GENERAL REQUIREMENTS

506B.1.5.1 Accepted Manufacturer: The hydropneumatic bladder surge control system shall be a BST-730 Bladder Surge Control System and have a BMD-100 monitoring device as designed and manufactured by Pulsco of Irvine, California or an Engineer approved equal. The hydropneumatic bladder surge control system shall be designed and supplied by a single manufacturer.

506B.1.5.2 Supplier: The Supplier must have a minimum of five (5) years of experience in design, supply, and startup of hydropneumatic bladder surge control systems.

506B.1.5.3 Surge Analysis: The Supplier must submit a surge analysis for the Engineer's approval or verify an analysis performed by others.

506B.1.5.4 Surge Control: The hydropneumatic bladder surge control system shall include a surge tank with replaceable membrane bladder.

506B.1.5.5 Personnel: Personnel representing the Surge Control System Supplier are required to verify the installation and instruct the Owner's personnel in the operation of the surge control system. A field surge test may be performed in conjunction with this site visit.

506B.1.6 SURGE ANALYSIS VERIFICATION

506B.1.6.1 Manufacturer Analysis: The manufacturer shall verify any analyses performed by others by utilizing the data supplied by the Owner.

506B.1.6.2 Surge Analysis: The surge analysis must show pipeline profile, initial flow rate, initial and maximum expanded air volume and envelope of maximum and minimum line pressure throughout the pipeline. In addition, a predicated pressure-time history at the pump station and at other critical points in the pipeline will also be required.

506B.1.6.3 Surge Tanks: The surge tanks must be designed to match the dynamics of the pumping station.

506B.1.6.4 Outflow Conditions: There shall be no less than 10 percent reserve water in the surge tank at the maximum outflow conditions (water seal volume).

506B.1.6.5 Results: Results of the surge analysis shall clearly indicate that the design and size of the surge tanks provided will adequately protect the system from excessive pressure surges and shall show the hydropneumatic bladder surge control system will meet the performance guarantees in Paragraph 506B.1.7.1.

506B.1.7 DESIGN AND PERFORMANCE REQUIREMENTS

The pressure transients in the pipeline following pump shutdown/startup from design operating conditions must not cause cavitation or water column separation at any point in the pipeline and must not exceed the pressure rating of the piping at any point in the pipeline.

506B.1.7.1 Performance Guarantee: The manufacturer shall provide a guarantee of performance and workmanship certifying that the system will meet all provisions documented herein.

Such performance may be verified by the following:

I. Functional test of the bladder monitoring and control system
II. Performance of field surge test (simulated power failure of pump(s))

506B.2 MATERIALS

506B.2.1 SURGE TANK

The surge tank shall be constructed of carbon steel for a Maximum Allowable Working Pressure (MAWP) of 200 pounds per square inch (psi) - gauge in accordance with the ASME Pressure Vessel Code, Section VIII, Division 1. The tank shall be bladder style as stated in Paragraph 506B.1.6.3. The tank shall have no moving parts, vanes, or elastomers. If determined to be required from the surge analysis verifications, a vortex breaker and differential nozzle shall be provided. The surge tank shall be provided with flanged line connections and oriented as shown in the project drawings.

The tank shall be equipped with manway, support structure, lifting lugs, pressure gauge, ball valves, gas charging valves, isolation valves, safety valves, gas/water level indication, and any other item deemed necessary for the proper functioning of the surge tank as provided by the manufacturer.

The tank shall also have attributes or items provided as described in Table 1. The dimension of the tank above the floor shall be as shown on the project drawings.

TABLE 1: SURGE TANK SPECIFICATIONS

Description	**Tank (1)**
Containing Volume	500 gal (66.84 CF)
Minimum Wall Thickness	1/4 inch
Diameter	48 inches maximum
Height Above Floor	Not to exceed 125 inches
Flanged Connection	6 inches
Flanged Differential Orifice	6 inches
Orifice Ratio (kin/kout)	2:1

506B.2.1.1 Internal Surface: The internal surface of the surge tank shall be sandblasted to the standards of SSPC-SP-10 and applied with two (2) coats of NSF Standard 61 approved epoxy coating. The epoxy coating shall be Sherwin Williams Macropoxy 646 or an approved equal, 5-10 mils per coat, 10 to 20 mils total DFT shall be used to. An alternate factory applied coating system on the tank interior may be used if found equivalent to those specified by the Engineer.

506B.2.1.2 External Surface: The external surface of the surge tank shall be sandblasted to SSPC-SP-6 and applied with one (1) coat of shop primer. Finish coat shall be applied in the field by Contractor with selection by the Owner. An alternate factory applied coating system on the tank exterior may be used if found equivalent to those specified by the Engineer.

506B.2.2 BLADDER

The bladder shall be pre-set with 10 psi of air prior to the exposing tank to line pressure. The bladder shall be replaceable and have a service life of 10 years.

When the water level is above the normal operating range, the air shall be manually added to the surge tank from a portable compressor. When water is below the normal operating range, air shall be manually vented from the surge tank through the air vent.

506B.2.2.1 Air Compressor: The air compressor shall be a twin cylinder, oil lubricated, industrial type with a 20 gallon ASME tank that has a minimum pressure gauge and pneumatic tires. The compressor shall be capable of delivering 4.0 cubic feet per minute (cfm) at 90 psi while driven with a 1.80 horsepower (hp) minimum, 120 volt (V), single phase motor. The compressor shall have a pressure capability of 150 psi and come with the required amount of recommended oil including one extra quart. The Contractor shall provide a rubber air hose, 25 feet in length, complete with couplers as required for the surge tank and compressor.

506B.2.2.1.1 Manufacture: The compressor shall be a Campbell Hausfeld Model DC200100 or an approved equal.

506B.2.3 MONITORING CONTROL SYSTEM

The monitoring system shall be able to control the air volume in the surge tank and monitor bladder integrity and shall be accomplished by maintaining the water level within a designed operating range.

506B.3 EXECUTION

506B.3.1 INSTALLATION

The installation shall be the responsibility of the Contractor; however, the supplier shall provide all components and assembly instructions to the Contractor for installation.

506B.3.3 START UP SUPPORT

The System Supplier shall provide start up support (one (1) trip, two (2) days) to test and instruct the project personnel on the supplied components. The Contractor shall coordinate with the System Supplier and Engineer to schedule start up support activities.

506B.3.4 TESTING

Testing shall be performed by the Contractor in the presence of the Engineer and a representative of the Supplier. Testing shall consist of a functional test of the level control system and may include a simulated power failure when pump(s) are running at maximum operating flow conditions.

Hydrostatic test the surge tank in accordance with the ASME Code for Unfired Pressure Vessels. Form U-1A "Manufacturers' Data Report for Unfired Pressure Vessels" shall be provided by the surge tank manufacturer to certify that the surge tank was built in accordance with ASME Code Rules for the construction of Unfired pressure vessels and inspected by a certified inspector. Copies of this form shall be supplied with the surge tank and included in the Operation and Maintenance Manual.

506B.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be as set forth in the Special Conditions.

509 CHLORINATION EQUIPMENT – INDEX

509 CHLORINATION EQUIPMENT

509.1 DESCRIPTION

The Contractor shall furnish all labor, materials, equipment, and incidentals required to provide a gas vacuum chlorination system and appurtenances as specified herein and as shown on the project drawings. Gas vacuum chlorination system components include, but are not limited to the following:

- Vacuum regulators, automatic switchovers and header assemblies
- Chlorinators
- Chlorine injectors
- Chlorine ejectors
- Chlorine Leak Detector
- Chlorine residual analyzers
- Chlorination pumps
- Weight Scales
- Wall mounting brackets, panels, and other accessories
- Chlorine gas and solution piping and tubing
- Secondary Containment Units

509.2 REFERENCE SPECIFICATIONS

Reference standards shall comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

- Standards of the Hydraulic Institute
- National Electric Code
- Standards of National Electrical Manufacturers Association
- Institute of Electrical and Electronic Engineers
- American National Standards Institute
- Standards of American Water Works Association
- Chlorine Institute Standards

509.3 SUBMITTALS

Submit for approval the following:

509.3.1 Manufacturer's Literature, Illustrations, Specifications, and Engineering Data: including dimensions, materials, size, weight, performance data and parts list for each component of the chlorination system.

509.3.2 Shop Drawings: showing fabrication, assembly, installation and plumbing and wiring diagrams. Drawings shall contain complete wiring, plumbing and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage or equipment and appurtenances, clearances for maintenance and operations.

509.3.3 Operation and Maintenance Manuals: Copies of proposed operation and maintenance manuals to be submitted for approval, two copies to be returned with required changes noted prior to fin submittal.

509.3.4 Test Results: Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

509.4 OPERATION AND MAINTENANCE DATA

Five copies of operation and five copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system start up, operation and shut down. Operation manuals shall include the manufacturer's name, model number, parts list, and a brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to acceptance.

509.5 GENERAL CHLORINATION SYSTEM

509.5.1 Chlorination System Requirements: The gas chlorination system shall be remote vacuum feed system designed to draw the pressurized chlorine gas from 150 pound cylinders into the twin lakes flow control station supply line as noted below:

a. Number of Systems — two (one as standby or trim chlorinator)
b. Location — chlorine storage room and pump room)
c. Station Design Flow
   - Minimum — 230 GPM
   - Maximum — 920 GPM
d. Chlorine Dose
   - Minimum — 0.5 ppm (0.5 mg/L)
   - Average — 1.2 ppm (1.2 mg/L)
   - Maximum — 4.0 ppm (4.0 mg/L)
e. Design Temperature — 1 to 20 °C
f. Discharge Pressure — 15 psi

509.5.2 Chlorination System General Equipment:

a. Two (2) vacuum feed chlorinators w/ process control units, injectors and vacuum regulators with automatic switchovers.
b. One (1) chlorine gas leak detector with two (2) sensor probes.
c. One (1) chlorine residual analyzer.
d. One (1) ton secondary containment vessel.
e. One (1) dual 150 pound secondary containment vessel.
f. Other appurtenances as specified herein and as shown on project drawing.

509.5.1 Chlorination System Signals: The signals from the flow meter and chlorine residual analyzer at Leupp-Dilkon Pump Station "0" will be used for automated control of Leupp-Dilkon Chlorination System. The SCADA system will relay flow and chlorine residual via 4 to 20 ma signals to the chlorination systems process control unit (PCU) for automated control. The SCADA System will also deliver and 24v digital signal to (PCU) to control chlorination system for modes of operation (shutdown, manual, and operation).

509.6 EQUIPMENT

509.6.1 Chlorinators: The chlorination system shall be the solution feed, remote vacuum type, wall mounted, consisting of two (2) gas feed chlorinators. Each chlorinator shall be sized to feed 75 lb/day of gas chlorine with maximum capacity of 200 lb/day. The accuracy of the chlorinators shall be within ±4% of the indicated feed rate of 75 lb/day and have operating ranges of 20:1 for manual and 10:1 for automatic.

The gas chlorinators shall be of the v-notch control type and consist of the following:

- **a.** A 10" glass rotameter.
- **b.** Direct acting diaphragm type vacuum gauge
- **c.** V-notch orifice with differential regulating valve
- **d.** Vacuum Regulators
- **e.** Chlorine injectors
- **f.** Automatic positioner, operated via 4 -20 mA signal from PCU
- **g.** Dedicated process control unit
- **h.** Operate on 120 V AC, 60 Hz power.

All the gas control components shall be constructed of chemical resistant plastics and shall be wall on the wall. The V-notch orifice shall consist of a 3-inch long v-grooved PVC plug which slides in a TFE annular seat. The rotameter tubes shall be constructed of glass and the rotator of approved chlorine resistant material. Chlorinators will be installed in chlorination feed room.

Chlorinators shall be Wallace and Tiernan V10 gas feed chlorinators or equal.

509.6.1.1 Vacuum Regulators: Three (3) vacuum regulators mounted on the secondary containment units shall be of the spring actuated type and shall be able to reduce the pressure of gas without venting and maintain a the flow constant for any given setting or the feed rate, regardless of changes in container and or manifold pressure. Each regulator shall be complete with a built in local vent valve, and a separate header valve.

Housing for regulators shall be constructed of PVC. The inlet header shall be made of copper and be capable of mounting directly to 150 pound chlorine cylinder and three (3) cylinder manifold with a chlorine institute type yoke connection. The vacuum regulators shall be installed in the chlorine storage room.

Vacuum regulators shall be Wallace and Tiernan model 510M/S or equals.

509.6.1.2 Injectors: Two (2) identical injectors, one for each chlorinator, shall be ¾" fixed throat deferential type injectors. Injectors shall receive chlorine gas and "supply" water and discharge the resulting chlorine solution through ¾" piping to the point of application. Maximum water pressure for the injector shall be 300 psi at 100° F. Injectors will be installed in chlorination feed room.

Injectors shall be Wallace and Tiernan ¾" V10 Chlorinator injectors or equal.

509.6.1.3 Automatic Positioner: For automatic control, this positioner shall use a reversible motor which shall position the V-notch plug over a 3" travel in precise response to an input 4 – 20 mA analog signal. The positioner shall have the following features:

1. NEMA 4X enclosure
2. Manual override via a knob to disengage the drive motor
3. Three (3) sits of operator contacts for system interface:
    - Manual Override
    - Maximum Position
    - Minimum Position

509.6.1.4 Ejector/Diffuser: The ejector shall be a ¾"standard brass body retractable corporation stop with PVC wetted diffuser ejector to the middle of pipe.

Chemical Ejector/Diffuser Assembly

1. Rating 150 psi.
2. Type: Insertion type PVC injection quill with 45° beveled end style
3. Connection: Brass or stainless steel corporation stop with threaded connection to tapped boss on control piping tee.
4. Construction: Chemical ejector assembly shall come complete with corporation stop, solution tube, solution tube adapter, packing nut, safety chain and threaded inlet connection. Solution tube shall be of a sufficient length to extend into the process pipe to between one third and one half the pipeline diameter. Injector should allow for rodding in place. Connection must include an acceptable safety device to prevent accidental withdrawal of injection solution tube while under pressure and/or surge conditions. All wetted components shall be compatible with the chemical services.
5. Manufacturer: Inyo Process or equal.

509.6.2 NOT FOR THIS PROJECT- Chlorination Pumps

509.6.3 Process Control Units (PCU): Two (2) process control units shall be supplied; one (1) for each chlorinator. The process control unit shall be specifically designed for automatic control of potable water disinfection systems. The PCU shall be a set-point controller of the chlorinator systems automatic positioner allowing for accurate control of gas feed equipment.

509.6.3.1 PCU Operation Range & Features: The PCU shall be a wall mounted unit with an operating range of 0 – 5 ppm (0 – 5 mg/L) of chlorine matching the chlorine residual analyzers and have the following features

- Continuous feedback control
- 4 control modes
- Selectable alphanumeric LCD display of parameters as well as output bar-graph.
- Menu driven electronics
- Isolated 4-20mA output
- RS-232 interface
- Four user-configurable alarm relays
- NEMA 4X enclosure
- Auto self-test and diagnostics menu
- Bumpless transfer when changing control modes

509.6.3.2 Control Modes: The PCU shall be capable of the following three (3) control modes for automatically controlling a V-notch actuator on a chlorinator:

- Manual
- Compound Loop with auto-tuning control technology that adapts the controller action to provide a quick response with minimal deviation for the setpoint.
- Direct Residual
- Flow Proportional

509.6.3.3 Input/Output:

509.6.3.2.1 Inputs

- Power 120 V ac

- Three 3 Analog Inputs
  - Flow Input Signal 4 – 20 mA
  - Residual Input Signal 4 – 20 mA
  - Spare Analog Input 4 – 20 mA

- Two (2) Digital Inputs initiated by 24 V DC SCADA contact
  - Input A – selectable for manual, shutdown, output driven to 0, 100% or 200%.
  - Input B – selectable for pre-programmed jobs 1 & 2

509.6.3.2.2 Outputs

- Control Output Increase/Decrease to Actuator
- Configurable Output 4 – 20 mA
    - Control Out/Actuator Position
    - Input Flow
    - Input Residual
- Four Alarm Relays Configurable as:
    - High Residual
    - Low Residual
    - High Flow
    - Low Flow
    - High Control Out
    - Low Control Out
    - Manual Mode
    - Shutdown
    - Power On
    - Loss of residual
    - Loss of flow

509.6.3.4 Manufacturer/Model: Wallace & Tiernan SFC PC Process Controller or equal.

509.6.4 Secondary Containment Vessels: Two (2) ChlorTainer Secondary Containment Vessels shall be supplied.

509.6.4.1 ChlorTainor 150-pound Dual Secondary Containment Vessel Features: The secondary containment vessel shall have the following features:

- Nitrogen System for Fail-Safe Valve Assembly
- Spare Parts Kit
- 285-psig @ 300°F Design Pressure
- 2.5-3.0 Mils DFT Inorganic Zinc Interior Paint
- 4-6 Mils DFT Epoxy with 2 Mils DFT Polyurethane Exterior Paint
- 1500-pound Vessel Weight
- Electronic Scale System with SCADA

In Dual Cylinder mode, gas from only one cylinder is processed at a time. When the first cylinder is empty, the feed is automatically switched to the second cylinder.

509.6.4.2 ChlorTainor One Ton Secondary Containment Vessel Features: The secondary containment vessel shall have the following features:

- Nitrogen System for Fail-Safe Valve Assembly
- Spare Parts Kit
- 250-psig @ 300°F Design Pressure
- 2.5-3.0 Mils DFT Inorganic Zinc Interior Paint
- 4-6 Mils DFT Epoxy with 2 Mils DFT Polyurethane Exterior Paint

- 2500-pound Vessel Weight
- Electronic Scale System with SCADA

The Ton Secondary Containment Vessel is built to accommodate a standard one-ton chlorine cylinder.

509.6.5 Chlorine Residual Analyzer: One (1) chlorine residual analyzer shall be supplied.

509.6.5.1 Features: The Analyzer shall have the following features:

- Continuously measure free chlorine in drinking water applications with a range of 0 – 5 ppm (0 – 5 mg/l).
- Utilize proven and universally accepted amperometric technology to provide reliable and stable measurement of chlorine residuals.
- Perform chlorine residual measurement without the use of reagents.
- Provide a 4-20 mA output signal for control or recording.

509.6.5.2 Flow Cell: The flow cell shall feature a bare-electrode type cell for free chlorine. The flow cell shall utilize a three (3) electrode technology. To ensure a stable, representative measurement of chlorine residual the flow cell shall maintain a constant sample flow rate.

509.6.5.2.1 Flow Cell Technical Data

Range (scale):	0 – 5 ppm (0 – 5 mg/l) free chlorine
Accuracy:	± 2% of full scale
Sensitivity:	± 1% of full scale
Repeatability:	± 2% of full scale
Stability:	± 2% of full scale under standard conditions
Response Time:	90% change < 20 seconds
Sample Temperature:	41° to 122° F
Sample Flow:	Constant 10gal/hr ± 18%
Inlet Pressure:	2 – 60 psi
Outlet Pressure:	0 psi
Sensor Cable:	length as required

509.6.5.3 Display and Electronics: The display electronics shall be housed in a NEMA 4X enclosure and have the following characteristics:

- Power Requirements: 115 V AC, 60 Hz
- Readout: 16-character, 2 line backlit LCD display
- Output Signal: 4 -20 mA isolated signal for chlorine residual
- External Alarms: 2 user configurable electromechanical relays.

509.6.5.4 Manufacturer/Model: Wallace & Tiernan Depolox 3 Plus Residual Analyzer with Bare Electrode Type Cell or equal.

509.6.6 Chlorine Leak Detection System: One (1) self-testing dual point chlorine gas detection system shall be supplied. The detection system shall be of a modular design consisting of sensor/transmitters and receiver/display modules.

509.6.6.1 System Technical Data: The Analyzer shall have the following characteristics:

- Chlorine Gas Detection Range: 0 – 10 ppm
- Power Requirements: 120 V AC, 60Hz
- Gas Alarm Setpoints: 2 independent setpoints (warning and alarm)
- Gas Concentration Output Signal: One (1) 4 – 20 mA signal for both monitoring points.
- Alarm Indicators: High intensity LED bar & Audible Horn
- Alarm Relays Three (3) assignable alarm relays, 120 V AC

509.6.6.2 Receiver: One (1) Dual Point Receiver with power supply module and battery back-up system shall be installed. The receiver shall be installed in the Chlorination Feed Room on the Control (North) Wall.

The receiver shall take sensor/transmitter signals and display the chlorine gas concentrations on a 4-digit LED Display for each of the monitored locations. The receiver shall also relay the gas concentrations for each monitored locations via an isloted 4 – 20 mA signal.

The receiver module shall power both sensor transmitters and be supplied with cabling to run from receiver to sensor/transmitter as required. The receiver shall be switch programmable for the full scale range. A single switch on the front panel shall provide alarm acknowledgment, reset functions, alarm relay inhibition, and system testing. Monitor shall contain alarm horn and LED light bar.

509.6.6.3 Sensor/Transmitter: Two (2) sensor/transmitter units shall be installed. The Sensors shall be installed as follows:

- One (1) Chlorine Storage Room – North Wall
- One (1) Chlorination Feed Room – Chlorination (South) Wall

Electrochemical Gas sensor shall attach directly to transmitter boxes with a water-tight seal. A short sensor cable plugs into the transmitter circuit board. All sensor/transmitter components shall be housed in a NEMA 4X enclosure

The Receiver module shall provide power to the Sensor/Transmitter modules through a two-conductor cable, which is also used to transmit the signal back to the Receiver. The Sensor/Transmitter may not be used with a separate power source.

509.6.5.4 Manufacturer/Model: Wallace & Tiernan Acutec 35 Dual Point Chlorine Gas Detection System or equal.

509.6.7 Piping and Fittings: Supply all pipes, fittings and connections as required for water supply, gas supply, solution delivery, drains, vents, and other appurtenances for complete installation of the chlorinator systems.

509.6.7.1 Rigid Piping, Fittings and Specials: All rigid piping, fittings, valves and specials for gas vacuum lines, supply lines and solution lines shall be schedule 80 PVC having a minimum pressure rating of 150 PSI. Joints shall be socket type unless otherwise called for.

509.6.7.2 Flexible Tubing: All flexible tubing shall be polyethylene tubing of the size called for on the project drawings.

509.6.7.3 Gas Manifolds: Gas manifolds shall connect three (3) 150 lb supply cylinders to a vacuum regulator and be wall mounted. Manifold shall have 5/8" female straight thread inlets and a 3/4" female straight thread outlet. Vacuum regulator shall connect to manifold with Chlorine Institute type yoke connection. Adapt gas supply lines as required.

509.6.7.4 Auxiliary Cylinder Valve: Auxiliary cylinder valves shall be Chlorine Institute yoke style valves.

509.6.8 Safety Equipment:

509.6.8.1 Emergency Repair Kit

One emergency repair kit, Chlorine Institute Emergency Kit "A", for 150 lb. chlorine cylinders complete with carrying case and an OSHA approved portable eye wash station shall be supplied to the Chlorine Storage Room.

509.6.8.2 Personnel Protective Equipment

The following shall be supplied within a wall mounted cabinet in the Chlorination Feed Room. Locate as directed by Engineer.

- Complete suit of PVC protective clothing.
- One pair of acid resistant gloves
- One pair of Protective boots
- Two set of air masks.

509.6.9 Spare Parts:

The following spare parts shall be provided:

- 10" Rotometer
- Compatible Vacuum Regulator

509.7 INSTALLATION

Chlorination equipment and appurtenances shall be installed as shown in the contract drawings and in accordance with the manufacturer's written instruction. All appurtenances required for a complete and operating chlorination system shall be provided, including such items as chlorinators, pumps, analyzers, gas monitors, piping, conduit, valves, wall sleeves, and controls.

Chlorinators shall be shop tested before being installed. Installation shall be in complete accordance with manufacturer's instructions and recommendations.

509.8 START-UP AND TEST

Prior to acceptance, an operational test of all chlorination equipment and accessories shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that the equipment is not electrically, mechanically, structurally or otherwise is defective; is in safe and satisfactory operating condition; and conforms to the specified operating characteristics. Any deficiencies found, during the testing, will be corrected and retested.

Contractor shall verify that structures, pipes, and equipment are compatible. Contractor shall make adjustments required to place system in proper operating condition.

A manufacturer's representative shall check and approve the installation before operation. The Manufacturer shall test operate the system in the presence of the Engineer and verify that the chlorination system conforms to requirements, and instruct station personnel on care and maintenance of the equipment. The Manufacturer shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

A field training course shall be provided for designated operating and maintenance staff members. Training shall provide for a total period of four hours at normal working time and shall start after the system is functionally complete, but prior to final acceptance test. Field training shall cover all of the items contained in the operating and maintenance manuals.

606 SLAB TRENCH DRAINS - INDEX

606 SLAB TRENCH DRAINS

606.1 GENERAL

606.1.1 DESCRIPTION

This item of work consists of furnishing all material, supplies, plant and labor required to construct cast-in-place slab trench drains and appurtenances in accordance with the contract documents.

606.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include, but are not limited to the following:

I. Section 101, Submittal Procedures

606.2 MATERIALS

606.2.1 TRENCH BODY

The trench body shall be composed of a semi-rigid material such as UV stabilized talc-filled polypropylene, High Density Polyethylene (HDPE), or composite polymer material. The trench body shall be 'U' shaped, have reinforcing ribs on the exterior, and have a means for connecting trench segments to form a water-tight joint. The trench segments shall graduate in depth to produce an invert slope of approximately 0.65 percent. The beginning depth of trench from the top of the slab to the trench invert shall be approximately 5 1/2 to 6 1/2 inches and the trench throat dimension shall be four (4) inches.

606.2.2 END CAPS

The high end cap shall be blank and extend from invert (or below) to top of slab forming a water-tight seal. The outlet end cap shall have a no-hub three (3) inches in diameter extension suitable for connecting to three (3) inch schedule 40 PVC pipe. The end cap shall seal water-tight against the trench body and extend to the slab level.

606.2.3 FRAME

The trench drain shall incorporate a rigid frame at the top of the trench body to provide for an acceptable structural and wear resistant edge at the slab top, additional strength for lateral pressure on the trench body, a means for attaching the grating to the trench, and appurtenances for stabilizing the unit while embedding in concrete. The frame shall be ductile iron or another approved material.

606.2.4 GRATES

The grates used shall be ductile iron, polypropylene or a combination of each as designated on the project drawings. Grates shall be provided with a suitable means for secure attachment to trench frames. Polypropylene load rating to be Class A. Ductile iron load rating shall be Class C. All types of grating shall be flush with the slab floor.

606.2.5 MANUFACTURER

Slab trench drains and appurtenances shall be as manufactured by WATTS or an approved equal.

606.3 EXECUTION

606.3.1 INSTALLATION

Installation shall be performed in accordance with the manufacturer's recommendations and as may be required on the project drawings.

606.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be as set forth in the Special Conditions.

701 STATION BUILDINGS - INDEX

701 STATION BUILDINGS

701.1 GENERAL

701.1.1 DESCRIPTION

This item of work shall consist of furnishing all materials, supplies, plant and labor required for the construction of pump stations, pressure reducing stations, control buildings, and accessories complete in accordance with applicable provisions of the International Building Code and the contract documents.

701.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related sections include, but are not limited to the following:

I. Section 101, Submittal Procedures
II. Section 301, Cast-In-Place Concrete

701.1.3 REFERENCES

I. APA- American Plywood Association, ASTM D24 – Grades and Properties, NDS-National Design Specification for Wood Construction, Nailed Connection (25.35)

701.1.4 SUBMITTALS

The Contractor shall submit information as required to verify compliance with the specifications for fabricated and manufactured items for station buildings in accordance with Section 101:

701.1.4.1 Shop Drawings:

I. Detail Drawings

701.1.4.2 Product Data:

I. Cement
II. Cold Weather Installation

701.1.4.3 Samples:

I. Concrete Masonry Units (CMU)
II. Anchors, Ties, and Bar Positioners
III. Joint Reinforcement

701.1.4.4 Design Data:

I. Pre-mixed Mortar
II. Unit Strength Method

701.1.4.5 Test Reports:

I. Field Testing of Mortar
II. Field Testing of Grout
III. Prism Test
IV. Masonry Cement

701.1.4.6 Certificates:

I. Concrete Masonry Units (CMU)
II. Anchors, Ties, and Bar Positioner
III. Expansion-Joint Materials
IV. Joint Reinforcement
V. Masonry Cement
VI. Admixtures of Masonry Mortar
VII. Admixtures for grout

701.1.4.7 Manufacturer's Instructions:

I. Masonry Cement

701.1.5 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered, stored, handled and protected to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

701.1.5.1 Masonry Units: Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C90.

701.1.5.2 Reinforcement, Anchors, and Ties: Steel reinforcing bars, coated anchors, ties, and joint reinforcements shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

701.1.5.3 Cementitious Materials, Sand and Aggregates: Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with the manufacturer's names and brands. Cementitious materials shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination or segregation.

701.1.6 PROJECT/SITE CONDITIONS

Conform to ACI 530/530.1 for hot and cold weather masonry erection.

701.1.6.1 Hot Weather Installation: Take the following precautions if masonry is erected when the ambient air temperature is more than 99 degrees Fahrenheit in the shade and the relative humidity is less than 50 percent, or the ambient air temperature exceeds 90 degrees Fahrenheit and the wind velocity is more than eight (8) miles per hour (mph).

All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than four (4) feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

701.1.6.2 Cold Weather Installation: Before erecting masonry when ambient temperature of mean daily air temperature falls below 40 degrees Fahrenheit or temperature of masonry units is below 40 degrees Fahrenheit, submit a written statement of proposed cold weather construction procedures for approval by the Engineer.

701.2 MATERIALS

701.2.1 WALL CONSTRUCTION MATERIALS

701.2.1.1 Blocks: The blocks used in wall construction shall be stuccoed or have architectural features on exterior walls as designated.

Any exposed concrete shall be given a rubbed finish. The color for the final coat and the block color shall be selected by the Owner.

The exterior walls of station buildings shall be as designated on the project drawings and/or as one of the following types:

I. Concrete Masonry Units (CMU) Split faced blocks
II. Stuccoed with a scratch coat of stucco netting (of galvanized 17gd.), brown coat and sand finish color coat.

701.2.1.1.1 Concrete Masonry Units (CMU): Submit samples and certificates as specified herein. Cement shall have:

I. Low alkali content and be of one brand
II. Hollow Non-Load-Bearing Units: ASTM C129, made with lightweight or normal weight aggregate
    i. Load-bearing units may be provided in lieu of non-load-bearing units.

701.2.1.1.1.1 Aggregates: Lightweight aggregates and blends of lightweight and heavier aggregates, in proportions used in producing the units, shall be tested for

stain-producing iron compounds in accordance with ASTM C641. The iron stain deposited on the filter paper shall not exceed the "light stain" classification as determined by the visual classification method. Use industrial waste by-products (air-cooled slag, cinders or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates. Slag shall comply with ASTM C989/C989M; Grade 80.

701.2.1.1.1.2 Kinds and Shapes: Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

701.2.1.1.1.2.1 Architectural Units: The architectural units shall have a patterned face shell. The face shell patterns shall be split ribbed. The units shall be integrally colored during manufacturing and the color shall be as chosen by the Owner. Patterned face shell shall be properly aligned in the completed wall.

701.2.1.2 Block Course Reinforcement: The block courses shall be reinforced with Dura-Wall or an approved equal as detailed on the project drawings.

701.2.1.3 Joint Reinforcement: The joint reinforcements shall be mill galvanizing, nine (9) Gauge side and cross rods (8 inch size) that conform to Class III, ASTM A951.

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A82/A82M, welded construction. Wire shall have a zinc coating conforming to ASTM A153/A153M, Class B-2, and shall be a minimum of 9 Gauge. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A641/A641M.

Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between cross wires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcements shall be provided with factory formed corners and intersections.

Submit one piece of each type used, including corner and wall intersection pieces, showing at least two cross wires in accordance with Section 101.

701.2.1.4 Reinforcing Steel: Reinforcing steel shall conform to provisions of ASTM A615 and be Grades 40 or 60 as designated on the project drawings.

701.2.1.5 Grout: The grout used to fill wall voids and cap beams shall be 4500 psi at 28 days as cured in laboratory conditions.

The grout mix shall be a 3/8 inch aggregate mix design and shall conform to ASTM C476 standards for fine grout. The cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Minimum grout strength shall be 4000 psi at 28 days as tested by ASTM C1019. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-mixed grout shall conform to ASTM C94/C94M.

701.2.1.5.1 Admixtures for Grout: In cold weather, a non-chloride based accelerating admixture may be used and is subject to approval of the Engineer. The accelerating admixture shall be non-corrosive, contain less than 0.2 percent chlorides, and conform to ASTM C494/C494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Engineer.

701.2.1.5.2 Grout Barriers: Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

701.2.1.6 Motor and Masonry Cement: Mortar shall be Type S and conform to the proportion specification of ASTM C270.

Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar. Use up to 40 percent Class F fly ash with Type IP cement in cement-lime mortar. Fly ash shall comply with ASTM C593.

701.2.1.6.1 Admixtures for Masonry Mortar: In cold weather, a non-chloride based accelerating admixture may be used but is subject to approval of the Engineer. The accelerating admixture shall be non-corrosive, contain less than 0.2 percent chlorides, and conform to ASTM C494/C494M, Type C. Submit the required certifications in accordance with Section 101.

701.2.1.6.2 Colored Mortar: Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color that matches the colored CMU as close as possible. The mortar coloring shall be chemically inert, of finely ground lime proof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement. The compressive strength of colored mortar shall equal 2500 pounds per square inch (psi).

701.2.1.6.3 Hydrated Lime and Alternates: Hydrated lime shall conform to ASTM C207, Type S.

701.2.1.6.4 Cement: Portland cement shall conform to ASTM C150/C150M, Type I, II, or III. Masonry cement shall conform to ASTM C91, Type S. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this Section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates

and on mixing to obtain the type of mortar required. Additives shall conform to requirements of Section 301.

701.2.1.6.5 Sand and Water: Sand shall conform to ASTM C144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

701.2.2 ROOF SYSTEM

701.2.2.1 Wood Structure: The roof structural system shall be composed of 2 inches by 12 inches or 2 inches by 10 inches fir-hemlock beams (rafters) as designated on the project drawings. The rafters shall be No. 1 or better by visual grading per the National Forest Products Association (NFPA).

Outside framing or facia members shall be pine. Framing brackets and panel sheathing clips shall be Simpson products or an approved equal. Station ceiling to consist of 1/2 inch exterior plywood. Ceiling joints shall be trimmed with screen door molding strips. The roof sheeting to the 5/8 inch CDX plywood with approved underlayment for metal roof panels.

701.2.2.1.1 Insulation: The Contractor shall provide R-19 Fiberglass Batts and 1/2 inch minimum plywood with continuous insect screen ventilation strips for soffit construction.

701.2.2.2 Steel Structure:

701.2.2.2.1 Metal Roof: The metal roof shall be 22 to 24 Gauge minimum and manufactured by "Pro-Panel", Firestone (UNA-CLAD UC14), or another approved equal. The roof panels shall conform to the requirements listed in Table 1.

TABLE 1: ROOF PANEL REQUIREMENTS

Item Description	Standard
Diaphragm Capacity	ASTM E 455-04
Air and Water Leakage	ASTM E 283/331
Class 4 Impact Resistance	UL 2218
Panel and Accessory Coating	ASTM A792
Panel Width	17.75 inch
Seam Height	1.75 inch
Uplift Resistance	UL 580 Class 90
Structural Performance	ASTM 330 & E1592
Fire Rating	UL Class A Rated Assemblies, UL 263 and UL 790
Hail Impact Rating	Class 4, UL 2218
Coating	Kynor 500/Hylar 5000 on Galvanized
Color	Selection by Owner

Fasteners	As recommended by Manufacturer with Nylon Washers
Warranty	25 Years

The roof trim shall generally conform to the shapes shown on the project drawings and shall be from the same manufacturer as the roof panels. The gutter and downspouts shall also be provided by the manufacturer of the roof panels. Fascia shall be trimmed with metal from the same manufacturer of roof panels and shall include gutter on the low side of the roof. Down spouts and splash pads shall be provided. Fasteners and sealing products shall be per the manufacturer's recommendations.

701.2.3 SLAB, FOOTING, AND/OR FOUNDATION

The ground level slab shall be reinforced and shall adhere to Section 301. Concrete shall conform to applicable provisions of provisions of ACI 318-08 and reinforcing steel shall conform to ASTM A615, Grade 60.

701.2.4 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A153/A153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A82/A82M. Wire ties or anchors in exterior walls shall conform to ASTM A641/A641M. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

Bar positioners, used to prevent displacement of reinforcing bars during construction, shall be factory fabricated from 9 Gauge steel wire or an approved equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

Submit two anchors, ties and bar positioners of each type used, as samples, in accordance with Section 101.

701.2.5 PERSONAL DOORS

Personal doors shall be heavy duty and meet the dimensional and operational requirements as shown on the project drawings. The doors shall be designated as Level 2, Physical Performance Level B, Model 1 with an insulated core per SDI/DOOR A250.8. The insulated core shall have a U-factor of 0.48 in accordance with SDI/DOOR 113. The Contractor shall provide an overlapping steel astragal for pairs of exterior steel doors.

701.2.5.1 Frames: The frames shall meet the dimensional and operational requirements shown on the project drawings and conform to SDI/DOOR A250.8.

701.2.5.2 Anchors: Anchors for securing the frame to the adjoining construction shall be provided. The anchors shall be steel, zinc-coated or painted with rust inhibitive paint, and

be no lighter than 18 Gage. A minimum of three (3) anchors shall be provided for each jamb. Frames higher than 7 1/2 feet shall require an additional anchor at each jamb for every additional 2 1/2 feet or fraction thereof.

701.2.5.3 Reinforcing Gages: Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Additional reinforcing for surface-applied hardware shall be built into the door at the factory. Door frames shall be punched to receive a minimum of two (2) rubber or vinyl door silencers on the lock side of single doors and one (1) silencer at the head of each leaf of double doors.

701.2.5.4 Door Hardware General: Promptly furnish template information or templates to door and frame manufacturers. Conform to BHMA A 156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

701.2.5.5 Hinges: Hinges shall conform to BHMA A156.1 and be 4 1/2 by 4 1/2 inches unless otherwise indicated. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges.

701.2.5.6 Mortise Locks and Latches: Mortise locks and latches shall be Series 1000, Operational Grade 1, Security Grade 2 and conform to BHMA A156.13. Provide mortise locks with escutcheons no less than 7 inches by 2 1/4 inches with bushing at least 1/4 inch long.

701.2.5.7 Exit Devices: Exit devices shall conform to BHMA A156.3 and be Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide escutcheons, no less than 7 by 2 1/4 inch.

701.2.5.8 Exit Locks with Alarms: Exit locks with an alarm shall conform to BHMA A156.5 and be Type E0431 with full-width horizontal actuating bar for single doors; Type E0431 with actuating bar or E0471 with actuating bar and top and bottom bolts, both leaves active for pairs of doors, unless otherwise specified. Provide terminals for connection to remote indicating pane.

701.2.5.9 Keying System: Provide a great master keying system, as directed, to match other water department locks.

701.2.5.10 Lock Trim: Lock trim shall be cast, forged, or heavy wrought construction and commercial plain design.

701.2.5.11 Knobs, Roses, and Escutcheons: Knobs, roses, and escutcheons shall conform to the minimum test requirements of BHMA A156.2 and BHMA A156.13 for reinforced knobs, roses, and escutcheons, provide outer shell of 0.035 inch thickness, and combined thickness of 0.070 inch, except for knob shanks, which are 0.060 inch thick.

701.2.5.12 Lever Handles: Provide lever handles in lieu of knobs where indicated. Conform to the minimum requirements of BHMA A156.13 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in BHMA A 156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

701.2.5.13 Keys: Furnish one (1) file key, one (1) duplicate key, and one (1) working key for each key change and for each master keying system. Furnish one (1) additional working key for each lock of each keyed-alike group. Stamp each key with appropriate key control symbol and "Do Not Duplicate." Door shall be keyed as directed to match other water department locks.

701.2.5.14 Doors Bolts: Door bolts shall conform to BHMA A156.16. Provide dustproof strikes for bottom bolts except for doors having metal thresholds. Automatic latching flush bolts shall be BHMA A156.3, Type 25.

701.2.5.15 Closers: Closers shall conform to BHMA A156.4, and be Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, full size covers, and other features necessary for the particular application. Size closers in accordance with the manufacturer's recommendations. Provide the manufacture's 10 year warranty.

Engrave each closer with the manufacturer's name or trademark, date of manufacture, and manufacturer's size designation. The location of the engraving shall be visible after installation.

701.2.5.16 Overhead Holders: Overhead holders shall conform to BHMA A156.8.

701.2.5.17 Closer Holder-Release Devices: Holder-Release Devices shall conform to BHMA A156.15.

701.2.5.18 Door Protection Plates: Door Protection Plates shall conform to BHMA A156.6. Kick Plates shall be two (2) inches less than the door width for single doors and one (1) inch less than the door width for pairs of doors. Provide 10-inch kick plates for flush doors.

701.2.5.19 Door Stops and Silencers: Door Stops and Silencers shall meet BHMA A156.16 and be Silencers Type L03011. Provide three (3) silencers for each single door, two (2) for each pair.

701.2.5.20 Padlocks: Padlocks shall conform to ASTM F883.

701.2.5.21 Thresholds: Thresholds shall conform to BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening outward, unless specified otherwise on the project drawings.

701.2.5.22 Weather Stripping Casketing: Weather stripping gasketing shall meet the standards of BHMA A156.22. Provide a set to include head and jamb seals, sweep strips, and for pairs of doors, astragals. Air leakage of weather stripped doors shall not exceed 1025 cubic feet per minute of air, per square foot of door area, when tested in accordance with ASTM E283. Provide weather stripping as one of the following items:

I. Extruded aluminum retainers no less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts
II. Provide clear (natural anodized) aluminum

701.2.5.23 Spring Tension Type: Springs shall be stainless steel not less than a 0.008 inch thick.

701.2.5.24 Rain Drips: Rain drips shall be extruded aluminum, no less than a 0.08 inch thick, and clear anodized.

701.2.5.25 Door Rain Drips: Door rain drips shall be approximately 1 1/2 inch high by 5/8 inch projection.

Overhead rain drips shall be approximately 1 1/2 inch high by 2 1/2 inch projection with length equal to overall width of door frame. Align bottom with door frame rabbet.

701.2.5.26 Special Tools: Provide special tools, such as spanner and socket wrenches, required to service and adjust hardware items.

701.2.5.27 Fasteners: Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Provide stainless steel or nonferrous metal fasteners that are exposed to weather. Provide fasteners of the type necessary to accomplish a permanent installation.

701.2.5.28 Finishes: Finishes shall conform to BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except BHMA 652 finish (satin chromium plated) for steel hinges. Provide hinges for exterior doors in stainless steel with BHMA 630 finish or chromium plated brass or bronze with BHMA 626 finish. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish. Match exposed parts of concealed closers to lock and door trim.

Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

701.2.6 PAINT

All painting shall be done by experienced workmen to produce a professional looking finished station. The Contractor shall furnish color charts for color selection by the Owner.

701.2.6.1 Exterior and Interior Wood Surfaces: Wood surfaces shall be primed with an oil-based primer and then painted with a latex or oil based paint by Sherman Williams, a quality exterior alkyd enamel, or an approved equal.

701.2.6.2 Steel: The Contractor shall provide a gloss enamel alkyd paint as Bar-Ox 452 by Devoe or approved equal for applications to primed steel surfaces.

701.2.6.3 Interior CMU: The sealer used for interior CMUs shall be Sherman Williams Pro Mar Block Filler or an approved equal. Paint for interior CMU's shall be a quality exterior latex paint.

701.3 EXECUTION

701.3.1 PREPARATION

Prior to starting work, masonry shall be inspected by the Engineer for compliance and defects. The Contractor shall coordinate with the Engineer a time for inspection.

701.3.1.1 Protection: Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

701.3.1.2 Air Temperature Requirements for Items Being Constructed:

701.3.1.2.1 Air Temperature 32 to 40 degrees Fahrenheit: Sand and mixing water shall be heated to produce mortar temperatures between 40 to 120 degrees Fahrenheit.

701.3.1.2.2 Air Temperature 25 to 32 degrees Fahrenheit: Sand and mixing water shall be heated to produce mortar temperatures between 40 to 120 degrees Fahrenheit. Temperature of mortar on boards shall be maintained above freezing.

701.3.1.2.3 Air Temperature 20 to 25 degrees Fahrenheit: Sand and mixing water shall be heated to provide mortar temperatures between 40 to 120 degrees Fahrenheit. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is more than 15 mph.

701.3.1.2.4 Air Temperature 20 degrees Fahrenheit and below: Sand mixing water shall be heated to provide mortar temperatures between 40 to 120 degrees Fahrenheit. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees Fahrenheit. Temperature of units when laid shall not be less than 20 degrees Fahrenheit.

701.3.1.3 Air Temperature Requirement Information for completed Masonry and Masonry Not Being Constructed:

701.3.1.3.1 Mean Daily Air Temperature 32 to 40 degrees Fahrenheit: Masonry shall be protected from rain or snow for 24 hours by covering with a weather-resistive membrane.

701.3.1.3.2 Mean Daily Air Temperature 25 to 32 degrees Fahrenheit: Masonry shall be completely covered with a weather-resistant membrane for 24 hours.

701.3.1.3.3 Mean Daily Air Temperature 20 to 25 degrees Fahrenheit: Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

701.3.1.3.4 Mean Daily Temperature 20 degrees Fahrenheit and Below: Masonry temperature shall be maintained above 32 degrees Fahrenheit for 24 hours by enclosure and supplementary heat, electric heating blankets, infrared heat lamps, or other approved methods.

701.3.1.4 Loads: Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

701.3.1.5 Surfaces: Clean surfaces on which masonry is to be placed of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

701.3.2 WALL CONSTRUCTION

Applicable provisions of ACI 530.1 regarding field observation and inspection, tolerances, workmanship, quality control and construction shall be made a part of theses Specifications. The Contractor shall coordinate and plan, as required, to ensure that wall openings in masonry units are of proper size for doors, exhaust fans, pipe sleeves, and other appurtenances.

701.3.2.1 Blocks: The building shall be of concrete block construction conforming to applicable provisions of ASTM C33, ASTM C90 and details shown on the project drawings.

701.3.2.1.1 Wall Exterior Blocks: Erect the exterior wall of the station buildings as shown on the project documents

701.3.2.2 Block Course Reinforcement: Concrete block courses shall be reinforced every other course with the proper lap.

701.3.2.3 Joint Reinforcement Installation: All exposed mortar joints shall be "tooled" and all block voids shall be filled with concrete. Anchor bolts shall be installed, as shown, in the cap beam around the top of the building walls. Both interior and exterior joints shall be tooled. All other appurtenances of this Section apply.

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than six (6) inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 5/8 in cover to either face of the unit.

701.3.2.4 Reinforcement Installation: Reinforcing steel for dowels and walls shall be at locations shown with a minimum lap of 30 bar diameters or as shown.

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, or other coatings which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within two (2) inches of tops of walls.

701.3.2.4.1 Positioning Bars: Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

701.3.2.4.2 Splices: Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

701.3.2.5 Grout: Grout installation shall adhere to Paragraph 701.2.1.5. Grout shall fill every cell.

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units, cells under lintel bearings on each side of the openings, lintels, and bond beams shall be filled solid with grout. Cells under lintel bearings shall be filled for the full height of openings.

Grout not in place within 1 1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

701.3.2.5.1 Vertical Grout Barriers for Fully Grouted Walls: Provide grout barriers not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

701.3.2.5.2 Horizontal Grout Barriers: Horizontal grout barriers shall be embedded grout barriers in mortar below cells of hollow units receiving grout.

701.3.2.5.3 Grout Holes and Cleanouts: Provide cleanout holes at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds five (5) feet. Where all cells are to be grouted, construct cleanout courses using bond beam units in an inverted position to permit cleaning of all cells. Provide cleanout holes at a maximum spacing of 32 inches where all cells are to be filled with grout. Establish a new series of cleanouts if grouting operations are stopped for more than four (4) hours. Cleanouts shall not be less than three (3) x four (4) inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

701.3.2.5.4 Grouting Equipment:

701.3.2.5.4.1 Grout Pumps: Pumping through aluminum tubes will not be permitted. Operate pumps to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, remove waste materials and debris from the equipment and dispose of it outside the masonry.

701.3.2.5.4.2 Vibrators: Internal vibrators shall maintain a speed of not less than 5000 impulses per minute when submerged in the grout. Maintain at least one spare vibrator on site at all times. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of the vibration to time necessary to produce satisfactory consolidation without causing segregation.

701.3.2.5.5 Grout Placement: Lay masonry to the top of a pour before placing the grout. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state.

701.3.2.6 Motor and Masonry Cement:

701.3.2.6.1 Mortar Mix: The Contractor shall mix mortar in a mechanically operated mortar mixer for at least three (3) minutes, but not more than five (5) minutes. Measure ingredients for mortar by volume. The ingredients not kept in containers, such as sand, shall be accurately measured using measuring boxes, mix water with the dry ingredients in a sufficient amount to provide a workable mixture that will adhere to the vertical surfaces of masonry units. Re-temper mortar that has stiffened because of loss of water through evaporation by adding water to restore the proper consistency and workability. Discard mortar that has reached its initial set or that has not been used within two (2) hours after mixing.

701.3.2.6.2 Laying Masonry Units: Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in running bond pattern. Facing courses shall be level with back-up courses.

Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and re-laid with fresh mortar. Air spaces, cavities, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or the other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb.

Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a non-furrowed full bed of mortar. Units shall be shoved into place so that the vertical joints are tight. Mortar will be permitted to protrude up to ½ inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below.

701.3.2.6.3 Forms and Shores: Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed less than 10 days after their installation.

701.3.2.6.4 Reinforced Concrete Masonry Units Walls: Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be two (2) by three (3) inches. Position reinforcement accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcement in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be

not less than 1/2 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tie them together.

701.3.2.6.5 Concrete Masonry Units: Units starting courses on concrete slabs, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Jamb units shall be of the shapes and sizes to conform with wall units.

701.3.2.6.6 Tolerances: Lay masonry plumb, true to line, with courses level. Keep bond pattern plumb throughout. Square corners unless noted otherwise.

701.3.2.6.7 Cutting and Fitting: Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp.

701.3.2.6.8 Jointing: The joints shall be tooled when the mortar is "thumbprint hard". Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

701.3.2.6.8.1 Tolled Joints: The joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed, and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

701.3.2.6.8.2 Door and Window Frame Joints: The exposed interior side of exterior frames, joints between frames, and abutting masonry walls shall be ranked to a 3/8 inch depth. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a 3/8 inch depth.

701.3.2.6.9 Joint Widths: Joint widths shall be as follows:

701.3.2.6.9.1 Concrete Masonry Unit: Concrete masonry units shall have 3/8 inch joints.

701.3.2.6.9.2 Embedded Items: Fill spaces around built-in items, such as embed anchors, accessories, pipe sleeves and other items required to be built-in as the masonry work progresses, with mortar. Fully embed anchors, ties and joint reinforcement set in mortar shall also have any spaces filled with mortar. Fill

cells receiving anchor bolts and cells of the first course below bearing plates with grout.

701.3.2.6.9.3 Unfinished Work: Step back unfinished work for joining with new work. Toothing may be resorted to only when specifically approved. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

701.3.2.6.9.4 Masonry Wall Intersections: Masonry bond each course at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown on the contract drawings.

701.3.2.7 Bond Beams: Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of ½ inch shall be maintained between reinforcement and interior faces of units.

701.3.2.8 Lintels:

701.3.2.8.1 Masonry Lintels: Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two (2) No.4 bars in bottom course (unless otherwise indicated on the drawings). Lintel reinforcement shall extend beyond each side of any masonry openings 40 bar diameters or 24 inches; whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

701.3.2.8.2 Precast Concrete and Steel Lintels: Construct precast concrete and steel lintels as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of eight (8) inches unless otherwise indicated on the drawings.

701.3.2.9 Bearing Plates: Set bearing plates for beams, joist girders and similar structural members to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated.

701.3.3 ROOF SYSTEM

701.3.3.1 Wood Structure: The rafters shall be placed on 16 inch centers unless otherwise noted. Each rafter shall be secured at each end with galvanized framing brackets, nailed to wall plates.

701.3.2.1.1 Insulation: R-19 Fiberglass Batts shall be placed between rafters as shown on the project drawings. A 1/2 inch minimum plywood with a continuous insect screen ventilation strip shall be used for soffit construction.

701.3.3.2 Steel Structure: Steel structure installation shall follow the requirements of the project drawings, relevant standards, and other provisions provided herein.

Installation of fasteners and sealing products shall be per the manufacturer's recommendation.

701.3.4 SLAB

Equipment pads and pump bases shall be accurately located prior to pouring. Weld plates and anchor bolts shall be placed in the slab during the pour at the locations called for. The outside stemwall edge shall be chamfered 3/4 inch and all other exposed edges shall be chamfered 3/4 inch or edged as otherwise directed. The Contractor shall coordinate and plan for the location of sleeves in or below the slab as required for passage of electrical and control conduit. The number, location, and size of these sleeves shall be submitted for approval prior to pouring.

The exposed edges of the floor slab shall be given a rubbed finish. The slab shall be given a smooth trowel finish.

701.3.5 PERSONAL DOORS

Doors shall be installed in accordance with SDI/DOOR A250.8. After erection, clean and adjust hardware. Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true with joints coped or mitered, well formed, and in true alignment. Dress exposed welded of soldered joints smooth. Door frame sections shall be designed for use with wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable. On wrap around frames provide a throat opening 1/8 inch larger than the actual masonry thickness. Design frames for exposed masonry walls to allow sufficient space between the inside back or trim and masonry to receive caulking compound.

701.3.5.1 Frames: Frames shall be installed in accordance with SDI/DOOR A250.11. Plumb, align, and brace frames securely until permanent anchors are set. Frame faces shall be continuously welded at the corner joints and have mechanical interlock or continuously welded stops and rabbits. Frames shall be welded in accordance with the Structural Welding Code Section 1 to 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded. Bottoms of frames shall be anchored with expansion bolts or powder-actuated fasteners. Build in or secure anchors to adjoining construction. Frames shall be backfilled with mortar and the interiors shall be coated with corrosion inhibiting bituminous material.

701.3.5.2 Anchors: Frames attached to masonry construction shall be fully grouted and anchored with corrugated or perforated steel straps.

701.3.5.3 Reinforcing Gages: Prepare doors and frames for hardware reinforcing gages in accordance with the applicable requirements of SDO/DOOR A250.8 and SDI/DOOR A250.6. Hardware reinforcing gages shall be located in accordance with the requirements of SDI/DOOR A250.8, as applicable. Drill and tap for surface-applied hardware onsite.

701.3.5.4 Door Hardware General: Clearly and permanently mark with manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts, and closers where the identifying mark will be visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover.

701.3.5.5 Hinges: Construct loose pin hinges for exterior doors so that pins will be non-removable when door is closed.

701.3.5.6 Mortise Locks and Latches: Cut escutcheons to suit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Install knobs and roses of mortise locks with screwless shanks and no exposed screws.

701.3.5.7 Rain Drips: Set rain drips in sealant and fasten with stainless steel screws.

701.3.5.8 Door Rain Drips: Align Door rain drips bottom with bottom edge of door.

701.3.5.9 Finishes: Install hardware in accordance with the manufacturer's printed installation instructions.

701.3.6 PAINT

All painting shall be done by experienced workmen to produce a professional looking finished station. The Contractor shall furnish color charts for color selection by the Owner.

701.2.6.1 Exterior and Interior Wood Surfaces: The wood surfaces shall be primed with one (1) coat of oil-based primer and then painted with two (2) coats of a paint listed in Paragraph 701.3.5.1.

701.2.6.2 Steel: All steel (except galvanized) shall be primed in the shop. Field welds shall be thoroughly brushed and primed. Already primed steel items shall receive two (2) coats of gloss enamel alkyd paint as Bar-Ox 452 by Devoe or an approved equal. Many manufactured products such as electrical cabinets, air compressors and motors may not need painting if they are suitable in color and if approved by the Engineer. Required touch-ups shall be with paint furnished by the manufacturer.

701.2.6.3 Interior CMU: Interior CMU's shall be sealed with Sherman Williams Pro Mar Block Filler or equal and painted with two (2) coats of quality exterior latex paint.

701.3.7 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs or splashing from masonry unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry that will be exposed or painted shall be ranked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high-pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stains, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

701.3.7.1 Dry-Brushing: Exposed concrete masonry units and exposed concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

701.3.8 PPROTECTION

Protect facing materials against staining. Cover top of walls with non-staining waterproof covering or membrane when work is not in progress. The top of the unfinished walls shall continue to be covered until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of two (2) feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loos mortar and foreign material.

701.3.9 TEST REPORTS

701.3.9.1 Field Testing of Mortar: A minimum of three specimens of mortar per day shall be sampled and tested. Spread a layer of mortar 1/2 to 5/8 inch thick on the masonry units and allow to stand for one minute. Prepare and test the specimens for compressive strength in accordance with ASTM C780. Submit test results.

701.3.9.2 Field Testing Grout: Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2500 psi at 28 days. Submit test results. Grout specified on this basis of the compressive (f'c) will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

701.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be as set forth in the Special Conditions.

702 FENCING - INDEX

702 FENCING

702.1 GENERAL

702.1.1 DESCRIPTION

The work covered in this section of the specifications consists of furnishing all plant, labor, equipment, appliances, and materials in installing site fencing complete with gates and appurtenances.

Fencing complete with top rail, tension wire, gates, and appurtenances shall be installed at the locations shown on the drawings.

702.1.2 RELATED SECTIONS

The Contractor shall review installation procedures under other sections and coordinate with the work which is related to this Section. Related Sections are:

I. Section 101, Submittal Procedures
II. Section 301, Cast-In-Place Concrete

702.1.3 APPLICABLE REFERENCES

ASTM A121 Specification for Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A392 Specifications for Zinc-Coated Steel Chain Link Fence Fabric
ASTM F626 Specification for Fence Fittings
ASTM F1083 Specification for Pipe Steel Hot Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F900 Specification for Industrial and Commercial Swing Gates.

702.1.4 SUBMITTALS

Engineer's approval is required for submittals. The following shall be submitted in accordance with Section 101:

702.1.4.1 Certificates: Chain Link Fence Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

Woven Wire Fence Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the woven wire fence and component materials meet the specified requirements.

702.2 MATERIALS

702.2.1 FENCE FABRIC

Fence fabric shall conform to the following:

702.2.1.1 Chain Link Fence Fabric: Fabric shall be in accordance with ASTM A392, Class 1, zinc coated steel wire with minimum coating weight of 1.2 ounces of zinc per square foot of uncoated wire surface. Fabric shall be fabricated of nine (9) Gauge open hearth, hot dipped galvanized wire, or as indicated on the drawings. Wire shall be woven into a two (2) inch mesh. Fabric height shall be six (6) feet. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom average.

702.2.1.2 Woven Wire: Woven wire shall be "V"-Mesh fence 72 inches high with horizontal wire gauged of 12.5 and a vertical wire gauge of 14. Fence shall be approximately 366 pound rolls and 65 feet long.

702.2.2 GATES

Gate shall be the type and swing shown. Gate frames shall conform to requirements of ASTM F 1083 for Schedule 40 standard weight pipe, and requirements of ASTM F 1043, for Group IA and Group IC, steel pipe with external coating Type A, nominal pipe size (NPS) 1 1/2. Gate fabric shall be as specified for chain link fabric. Gate leaves more than eight (8) feet wide shall have both intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than eight (8) feet wide shall have truss rods or intermediate braces. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Heavy duty malleable latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position. For high security applications, each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

702.2.3 POSTS

702.2.3.1 Metal Posts for Chain Link Fence: Metal posts shall conform to requirements of ASTM F 1083 for Schedule 40 standard weight pipe, and strength and coating requirements of ASTM F 1043, Group IA and Group IC. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

702.2.3.2 Metal Posts for Farm Style Fence: Metal posts shall conform to ASTM A 702 zinc-coated, T-section, length as indicated. Accessories shall conform to ASTM A 702.

702.2.4 BRACES AND RAILS

ASTM F 1083, and ASTM F 1043, Group IA and Group IC, size NPS 1-5/8. Steel pipe, zinc-coated.

702.2.5 WIRE

702.2.5.1 Tension Wire: Tension wire shall be Type I or Type II, Class 4 coating, in accordance with ASTM A 824.

702.2.5.2 Barbed Wire for Farm Style Fence: Barbed wire shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire with 14 gauge, round, 4-point barbs spaced no more than five (5) inches apart.

702.2.6 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire support arms shall be the single arm type and of the design required for the post furnished. Tie wire for attaching fabric to rails, braces and posts shall be nine (9) Gauge steel wire and match the coating of the fence fabric. Tie wires for attaching fabric to tension wire on high security fences shall be 16 Gage stainless steel. The tie wires shall be a double loop and 6 1/2 inches in length. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified.

702.2.7 BARBED TAPE

Reinforced barbed tape, single coil, for fence toppings shall be fabricated from 430 series stainless steel with a hardness range of Rockwell (30N) 37-45 conforming to the requirements of ASTM A 176. The stainless-steel strip shall be 0.025 inch thick by one (1) inch wide before fabrication. Each barb shall be a minimum of 1.2 inch in length, in groups of four (4), spaced on four (4) inch centers. The stainless-steel core wire shall have a 0.098-inch diameter with a minimum tensile strength of 130 ksi and shall be in accordance with ASTM A 478.

702.2.8 CONCRETE

Concrete to conform to applicable provisions of Section 301 of these Specifications.

702.3 EXECUTION

702.3.1 INSTALLATION

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Fencing shall be as detailed in project drawings. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Fabric shall be pulled tight and attached to post, top rail, padlocking and open-close stops. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

702.3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a two (2) inch clearance between the bottom of the fabric and finish grade.

702.3.3 POST INSTALLATION

702.3.3.1 Posts for Chain Link Fence: Posts shall be set plumb, in alignment and tops graded to present smooth, pleasing lines. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 18 inches in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least one (1) inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids, and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. For high security fences, fence post rigidity shall be tested by applying a 50 pound force on the post, perpendicular to the fabric, at five (5) feet above ground; post movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position; every tenth (10^{th}) post shall be tested for rigidity; when a post fails this test, further tests on the next four (4) posts on either side of the failed post shall be made; all failed posts shall be removed, replaced and retested at the Contractor's expense.

702.3.3.2 Posts for Farm Style Fence: Metal posts shall be driven or set in concrete as indicated.

702.3.4 RAILS

702.3.4.1 Top Rail: Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail, if required for high security fence, shall be installed as indicated on the drawings.

702.3.4.2 Bottom Rail: The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

702.3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over six (6) feet in height. A center brace or two (2) diagonal truss rods shall be installed on 12-foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences six (6) feet high or less if a top rail is installed.

702.3.6 TENSION WIRES

Tension wires shall be installed along the bottom of the fence line and attached to the terminal posts of each stretch of the fence. Bottom tension wire shall be installed within the bottom six (6) inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

702.3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15 inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 15 inch intervals and fastened to all rails and tension wires at approximately 24 inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be two (2) ± 1/2 inch above the ground. For high security fence, after the fabric installation is complete, the fabric shall be exercised by applying a 50 pound push-pull force at the center of the fabric between posts; the use of a 30 pound pull at the center of the panel shall cause fabric deflection of two (2) inches ± 1/2 inch when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be re-secured and retested at the Contractor's expense.

702.3.8 BARBED WIRE SUPPORTING ARMS AND BARBED WIRE

702.3.8.1 General Requirements: Barbed wire shall be installed as detailed on project drawings. Barbed wire supporting arms and barbed wire shall be installed as indicated and as recommended by the manufacturer. Supporting arms shall be anchored to the posts in a manner to prevent easy removal with hand tools. Barbed wire shall be pulled taut and attached to the arms with clips or other means that will prevent easy removal.

702.3.8.2 Barbed Wire for Farm Style Fence: Wire shall be installed on the side of the post indicated. Wire shall be pulled taut to provide a smooth uniform appearance, free from sag. Wire shall be fastened to line posts at approximately 15 inch intervals unless indicated otherwise.

702.3.9 GATE INSTALLATION

Gates shall be installed at the locations shown. Gates shall have provisions for padlocking. Hinged gates shall be mounted to swing as indicated. Latches, stops and keepers shall be installed as required. Hinge pins and hardware shall be welded or otherwise secured to prevent removal. For farm style fencing, standard metal gate assemblies with frame and fittings necessary for complete installation as shown.

702.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this section of specifications shall be in accordance with provisions of the Special Conditions.

704 HOIST, BRIDGE CRANE - INDEX

704 HOIST, BRIDGE CRANE

704.1 GENERAL

704.1.1 DESCRIPTION

The pump station shall be equipped with a hoist configuration for lifting and moving pump components as required for maintenance, replacement, and associated operations. The bridge crane hoist shall be capable of picking and moving a minimum of _2_ ton(s).

704.2 MATERIALS

704.2.1 STRUCTURAL FRAME

Hoist girders, columns, bridge, and other attachments shall conform to the weights, dimensions and configurations shown on the project drawings. The frame numbers shall be shop coated in accordance with SSPC Alkyd Paint System No. 2.00 including commercial blast cleaning and three (3) coat system, (primer, intermediate and finish) for a total dry film thickness of 4.5 mils. Finish color shall be selected by the Owner. Welds and adjacent areas shall be cleaned by grinding or wire brushing and coated with a similar system.

704.2.2 HOIST

The hoist hooks shall be drop forged, heat treated with spring type latch. The hooks shall be capable of rotating 360 degrees. The hoist shall have a mechanical load brake that will hold a capacity load stationary at any position. The pull to lift load for _2_ ton(s) lift shall not exceed 80 pounds.

The hook to hook dimension shall not exceed 15 inches in a fully retracted position with the operating chain at 5 1/2 feet above the floor. The chain length shall be such as to have pick capability from the retracted position to eight (8) feet below.

The hoist shall be ACCOLIFT or an approved equal.

704.2.3 TROLLEY

The trolley shall be a plain type with adjustable features to enable a fit to the beam specified. The trolley shall be rated for a minimum of _2_ ton(s) as ACCOLIFT or an approved equal and the trolley wheels shall have lifetime lubricated ball bearings.

704.2.4 END TRUCKS

The end trucks shall be ‘push’ type top running suitable for operating on 40 pound (lbs.) rail. End trucks shall be ACCO/WRIGHT series 430 or an approved equal with maximum truck load capacity of 11,000 lbs. Five (5) copies of the instruction and parts manual shall be provided.

704.2.5 RAIL

The truck rails shall be ASCE, 40 pounds, and attached to crane girders. The truck stops shall be provided.

704.3 EXECUTION

This Part will not be used for this Section.

704.4 MEASUREMENT AND PAYMENT

Measurement and payment for items of work covered by this Section of the Specifications shall be as set forth in the Special Conditions.

901 DESIGN CODES AND REFERENCES - INDEX

901 DESIGN CODES AND REFERENCES

901.1 GENERAL

901.1.1 DESCRIPTION

The publications listed below form a part of the specifications to the extent referenced. The publications are referred to within the text by the basic designation only.

901.2 REFERENCES

All Design Codes and References in this Specification shall use the latest editions available complete with applicable withdrawls.

901.2.1 EARTHWORK

AASHTO – STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGES

-AASHTO M 145 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction

-AASHTO T 180Moisture-Density Relations of Soils Using a 4.54-kg (10 lb.) Rammer and a 457-mm (18-in) Drop

-AASHTO T 224 Correction for Coarse Particles in the Soil Compaction Test

ANSI – AMERICAN NATIONAL STANDARDS INSTITUTE

-ANSI A10.6 Demolition Operations - American National Standard for Construction and Demolition Operations

ASTM INTERNATIONAL

-ASTM A 975 Standard Specification for Double–Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Poly (Vinyl Chloride) (PVC) Coating

-ASTM C 29 / C29M Bulk Density (“Unit Weight”) and Voids in Aggregate

-ASTM C 88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

-ASTM C 117 Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing

-ASTM C127 Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

-ASTM C128 Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate

-ASTM C 131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

-ASTM C136 / C136M Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

-ASTM D 75 Sampling Aggregates

- ASTM D 422 Particle-Size Analysis of Soils

-ASTM D448 Sizes of Aggregate for Road and Bridge Construction

- ASTM D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. Ft.)

-ASTM D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

-ASTM D 854 Specific Gravity of Soil Solids by Water Pycnometer

-ASTM D1140 Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing

-ASTM D1241 Materials for Soil-Aggregate Subbase, Base, and Surface Courses

-ASTM D1556 / D1556M Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

-ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)

-ASTM D 2216 Laboratory Determination of Water (Moisture) Content of Soil and Rock by

-ASTM D 2434 Mass Permeability of Granular Soils (Constant Head)

-ASTM D 2487 Soils for Engineering Purposes (Unified Soil Classification System)

-ASTM D2488 Description and Identification of Soils (Visual-Manual Procedure)

-ASTM D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

-ASTM D 3017 Water content of Soil and Rock in Place by Nuclear Method

-ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

-ASTM D 4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils

-ASTM D4355 / D4355M Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus

-ASTM D4491 / D4491M Standard Test Methods for Water Permeability of Geotextiles by Permittivity

-ASTM D4595 Tensile Properties of Geotextiles by the Wide-Width Strip Method

-ASTM D4632 / D4632M Grab Breaking Load and Elongation of Geotextiles

-ASTM D4751 Determining Apparent Opening Size of a Geotextile

-ASTM D4873 / D4873M Identification, Storage, and Handling of Geosynthetic Rolls and Samples

-ASTM D4867 / D4867M Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures

-ASTM D5321 / D5321M Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear

-ASTM D6638 Determining Connection Strength between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks)

-ASTM D6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

-ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

-ASTM M 145 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction

-ASTM D3282 Standard Practice for Classification of Soils and Soil-Aggreate Aggregate Mixtures for Highway Construction Purposes

-AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

901.2.2 CONCRETE AND MASONRY

AASHTO – STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGES

- Design — Allowable Stress Design

  Fc = .40 f'c
  Grade 40 Reinforcement = 20,000 psi
  Grade 60 Reinforcement = 24,000 psi

ACI – AMERICAN CONCRETE INSTITUTE

-ACI 305.R-10 Standard Specification for Hot Weather Concreting

-ACI 306.1-90 Standard Specifications for Cold Weather

-ACI 318 / 318M Building Code Requirements for Structural Concrete and Commentary

-ACI 530 / 530.1 Building Code Requirements and Specifications for Masonry Structures and Related Commentaries

ASTM INTERNATIONAL

-ASTM A 185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

-ASTM A1064 / A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

-ASTM A615 / A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

-ASTM A996 / A996M Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement active

-ASTM C31 / C31M Standard Practice for Making and Curing Concrete Test Specimens in the Field

-ASTM C33 / C33M Standard Specification for Concrete Aggregates

-ASTM C39 / C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

-ASTM C42 / C42M Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

-ASTM C90 Standard Specification for Loadbearing Concrete Masonry Units

-ASTM C91 / C91M Standard Specification for Masonry Cement

-ASTM C 94 / C 94M Ready-Mixed Concrete

-ASTM C114 Standard Test Methods for Chemical Analysis of Hydraulic Cement

-ASTM C129 Standard Specification for Nonloadbearing Concrete Masonry Units

-ASTM C140 / C140M Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

-ASTM C143 / C143M Standard Test Method for Slump of Hydraulic-Cement Concrete

-ASTM C144 Standard Specification for Aggregate for Masonry Mortar

-ASTM C150 / C150M Standard Specification for Portland Cement

-ASTM C171 Standard Specification for Sheet Materials for Curing Concrete

-STM C172 / C172M Standard Practice for Sampling Freshly Mixed Concrete

-ASTM C188 Standard Test Method for Density of Hydraulic Cement

-ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes

-ASTM C231 / C231M Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

-ASTM C260 / C260M Standard Specification for Air-Entraining Admixtures for Concrete

-ASTM C270 Standard Specification for Mortar for Unit Masonry

-ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

-ASTM C387 / C387M Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

-ASTM C476 Standard Specification for Grout for Masonry

-ASTM C494 / C494M Standard Specification for Chemical Admixtures for Concrete

-ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

-ASTM C920 Standard Specification for Elastomeric Joint Sealants

-ASTM C1017 / C1017M Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

-ASTM C1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

-ASTM C1262 / C1262M Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units

-ASTM C1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction

-ASTM C1372 Standard Specification for Dry-Cast Segmental Retaining Wall Units

-ASTM C1567 Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

-ASTM C1602 / C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

-ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

NATIONAL CONCRETE MASONRY ASSOCIATION (NCMA)

NCMA TR127B Design Manual for Segmental Retaining Walls

901. 2.3 STREETS AND RELATED WORK

AASHTO – STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGES

-AASHTO MP 1a Performance Graded Asphalt Binder Asphalt Institute

-AASHTO M 20 Penetration-Graded Asphalt Cement

-AASHTO M 81 Cut-Back Asphalt (Rapid-Curing Type)

-AASHTO M 82 Cut-Back Asphalt (Medium-Curing Type)

-AASHTO M 199M / M 199 Standard Specification for Precast Reinforced Concrete Manhole Sections

-AASHTO M 198 Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

-AASHTO M 226 Viscosity Graded Asphalt Cement

-AASHTO M 247 Glass Beads Used in Traffic Paints

-AASHTO R 66 Standard Practice for Sampling Asphalt Materials

-AASHTO T 40 Sampling Bituminous Materials

-AASHTO T 102 Spot Test of Asphaltic Materials

-AASHTO T 301 Standard Method of Test for Elastic Recovery Test of Asphalt Materials by Means of a Ductilometer

ASTM INTERNATIONAL

-ASTM D70 Standard Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method)

-ASTM D140 / D140M Standard Practice for Sampling Asphalt Materials

-ASTM D242 / D242M Standard Specification for Mineral Filler for Bituminous Paving Mixtures

-ASTM D413 Standard Test Methods for Rubber Property—Adhesion to Flexible Substrate

-ASTM D546 Standard Test Method for Sieve Analysis of Mineral Filler for Asphalt Paving Mixtures

-ASTM D692 / D692M Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures

-ASTM D946 / D946M Standard Specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction

-ASTM D979 / D979M Standard Practice for Sampling Bituminous Paving Mixture

-ASTM D 995 Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

-ASTM D1073 Standard Specification for Fine Aggregate for Asphalt Paving Mixtures

-ASTM D1188 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples

-ASTM D1250 Standard Guide for Use of the Petroleum Measurement Tables

-ASTM D 1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

-ASTM D2027 / D2027M Standard Specification for Cutback Asphalt (Medium-Curing Type)

-ASTM D2041 / D2041M Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

-ASTM D2172 / D2172M Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures

-ASTM D2397 / D2397M Standard Specification for Cationic Emulsified Asphalt

-ASTM D2726 / D2726M Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt Mixtures

-ASTM D2995 Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors

-ASTM D3381 / D3381M Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction

-ASTM D4280 Standard Specification for Extended Life Type, Nonplowable, Raised Retroreflective Pavement Markers

-ASTM D4505 Standard Specification for Preformed Retroreflective Pavement Marking Tape for Extended Service Life

-ASTM D4439 Standard Terminology for Geosynthetics

-ASTM D4491 / D4491M Standard Test Methods for Water Permeability of Geotextiles by Permittivity

-ASTM D4533 / D4533M Standard Test Method for Trapezoid Tearing Strength of Geotextiles

-ASTM D4632 / D4632M Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

-ASTM D4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile

-ASTM D4873 / D4873M Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

-ASTM E28 Standard Test Methods for Softening Point of Resins Derived from Pine Chemicals and Hydrocarbons, by Ring-and-Ball Apparatus

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

-FHWA NHI-00-043 Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines (ISDDC)

902.2.4 WATER AND SANITARY SEWER LINES

AASHTO

-AASHTO M 252 Standard Specification for Corrugated Polyethylene Drainage Pipe

ASTM INTERNATIONAL

-ASTM A536 Standard Specification for Ductile Iron Castings

-ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts

-ASTM B42 Standard Specification for Seamless Copper Pipe, Standard Sizes

-ASTM B88 Standard Specification for Seamless Copper Water Tube

-ASTM C478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections

-ASTM C920 Standard Specification for Elastomeric Joint Sealants

-ASTM C923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

-ASTM C990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

-ASTM D1149 Standard Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment

-ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120

-ASTM D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

-ASTM D2466 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

-ASTM D2467 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

AWWA – AMERICAN WATER WORKS ASSOCIATION

-AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

-AWWA C104 / A21.4 Cement–Mortar Lining for Ductile-Iron Pipe and Fittings

-AWWA C105 Polyethylene Encasement for Ductile Iron Pipe

-AWWA C110 Ductile Iron and Gray Iron Fittings

-AWWA C111 Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings

-AWWA C115 / A21.15 Flanged Ductile - Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

-AWWA C150 / A21.50 Thickness Design of Ductile-Iron Pipe

-AWWA C800 Underground Service Line Valves and Fittings

-AWWA C151 / A21.51 Ductile - Iron Pipe, Centrifugally Cast

-AWWA C502 Dry-Barrel Fire Hydrants

-AWWA C700 Cold-Water Meters – Displacement Type, Bronze Main Case

-AWWA C701 Cold-Water Meters - Turbine Type, for Customer Service

-AWWA C702 Cold-Water Meters - Compound Type

-AWWA C704 Propeller - Type Meters for Waterworks Applications

-AWWA C706 Direct-Reading, Remote - Registration Systems for Cold - Water Meters

-AWWA C707 Encoder-Type Remote - Registration Systems for Cold - Water Meters

-AWWA C509 Resilient-Seated Gate Valves for Water Supply Service

-AWWA C515 Reduced - Wall, Resilient-Seated Gate Valves for Water Supply Service

-AWWA C550 Protective Interior Coatings for Valves and Hydrants

-AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances

-AWWA C605 Water Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings

-AWWA B301 Liquid Chlorine

-AWWA C651 Standard for Disinfecting Water Mains

-AWWA C652 Standards for Disinfecting Water Storage Facilities

MSS - MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY

-MSS SP-80 Bronze Gate, Globe, Angle and Check Valves

UL - UNDERWRITERS LABORATORIES

-UL 246 Safety Hydrants for Fire - Protection Service

-UL 262 Gate Valves for Fire - Protection Service

-UL 312 Check Valves for Fire - Protection Service

-UL 789 Indicator Posts for Fire - Protection Service

UBPPA - UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

-UBPPA UNI-B-3 Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch)

-UBPPA UNI-B-8 Recommended Practice for the Direct Tapping of Polyvinyl Chloride (PVC) Pressure Water Pipe (Nominal Diameters 6-12 Inch

ISO - INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

-ISO 1940-1 Mechanical Vibration – Balance Quality Requirements for Rotors in a Constant

-ISO 21940 Mechanical vibration - Rotor balancing - Part 11: Procedures and tolerances for rotors with rigid behavior (Rigid) State - Part 1: Specification and Verification of Balance Tolerance - International Restrictions

-ISO 2858 End Suction Centrifugal Pump (Rating 16 Bar) Designation Nominal Duty Point and Dimensions – International Restrictions

-ISO 5199 Technical Specifications for Centrifugal Pumps, Class II

901.2.5 STRUCTURES

ASTM INTERNATIONAL

-ASTM A53 / A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

-ASTM A116 Standard Specification for Metallic-Coated, Steel-Woven Wire Fence Fabric

-ASTM A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

-ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

-ASTM A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Product

-ASTM A392 Standard Specification for Zinc-Coated Steel Chain - Link Fence Fabric

-ASTM A641 / A641M Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire

-ASTM A764 Standard Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs

-ASTM A780 / A780M Standard Practice for Repair of Damaged and Uncoated Areas of Hot - Dip Galvanized Coatings

-ASTM A824 Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for use with Chain Link Fence

-ASTM A853 Standard Specification for Steel Wire, Carbon, for General Use

-ASTM D4541 Standard Test Method for Pull - Off Strength of Coatings Using Portable Adhesion Testers

-ASTM F626 Standard Specification for Fence Fittings

-ASTM F900 Standard Specification for Industrial and Commercial Steel Swing Gates

-ASTM F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework

-ASTM F1083 Standard Specification for Pipe, Steel, Hot - Dipped Zinc - Coated (Galvanized) Welded, for Fence Structures

AWWA – AMERICAN WATER WORKS ASSOCIATION

-AWWA D100 Welded Carbon Steel Tanks for Water Storage

SSPC – SOCIETY FOR PROTECTIVE COATINGS

-SSPC-SP10 Neat White Blast Cleaning

-SSPC-SP6 Commercial Blast Cleaning

NSF - NATIONAL SCIENCE FOUNDATION

-NSF 61 All Welded Materials (Potable Water)

901.2.6 ELECTRICAL

NEC - NATIONAL ELECTRIC CODE

NFPA – NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS

IEEE – INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

GJU – CITY OF GALLU JOINT UTILITIES – ELECTRICAL LINE, METER DISCONNECT AND SERVICE STANDARDS

901.2.7 SAFETY

OSHA – CONSTRUCTION STANDARDS FOR EXCAVATION

MUTCD - MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS

NM ONE CALL INC. – UNDERGROUND UTILITY DESIGN AND EXCAVATION LOCATES

NESC – NATIONAL ELECTRICAL SAFETY CODE