TECHNICAL SPECIFICATIONS

DIVISION 2

SITE WORK

Section 02200

SITE PREPARATION

1.0 GENERAL

1.01 SECTION INCLUDES

A Removal of topsoil, stripping and stockpiling, clearing and grubbing.

B Removal and disposal of waste materials, excess materials, debris and trash.

C Removal of obstructions.

D Excavation and fill.

E Salvaging of designated item.

F References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 01500 – Temporary Facilities and Controls
5. Section 02255 – Bedding, Backfill and Embankment Material
6. Section 02330 – Embankment
7. Section 01140 – Contractor's Use of Premises

G Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 4318, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for Work performed under this Section. Include cost in Bid Items for which this Work is a component.

B If Site Preparation is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit embankment material sources and product quality information in accordance this Section.

1.04 TESTING

A Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 MATERIALS

A Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.

3.0 EXECUTION

3.01 CLEARING AND GRUBBING.

A Clear Project Site of trees, shrubs, and other vegetation, except for those designated by Owner to be left standing.

B Use only hand methods for grubbing inside drip line of trees designated to remain.

C Completely remove stumps, roots, and other debris protruding through ground surface.

1. On areas required for roadway, channel, or structural excavation, remove stumps, 2" diameter or larger limbs and roots, to depth of 2 feet below lower elevation of excavation.
2. On areas required for embankment construction, remove 2" diameter limbs, stumps and roots to depth of 2 feet below ground surface
3. Trees and stumps may be cut off as close to natural ground as practicable on areas which are to be covered by at least 3 feet of embankment

D Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to density equal to adjacent original ground.

E Complete operations by bulldozing, blading, and grading so that prepared area is free of holes, unplanned ditches, abrupt changes in elevations and irregular contours, and preserve drainage of area.

1. Blade entire area to prevent ponding of water and to provide drainage, except in areas to be immediately excavated

3.02 TOPSOIL STRIPPING AND STOCKPILING

A Obtain approval of topsoil quality before excavating and stockpiling.

B Excavate topsoil for esplanades and areas to receive grass or landscaping from areas to be further excavated.

C Topsoil Stripping:
1. Remove growths of grass from areas before stripping.
2. Topsoil is defined as surface soil found of depth of not less than 4 inches.
3. Strip topsoil to depths encountered.
4. Perform stripping in a manner to prevent intermingling of topsoil with underlying sterile subsoil and remove objectionable materials, including clay lumps, stones over 2 in. in diameter, weeds, roots, leaves, and debris.
5. Where trees are designated by Owner to be left standing, stop topsoil stripping at extreme limits of tree drip line to prevent damage to main root system.

D Topsoil Stockpiling:
1. Stockpile in areas designated on Plans.
2. Construct storage piles to freely drain surface water.
3. Cover storage piles, if required to prevent wind-blown dust.
4. Stockpile topsoil to depth not exceeding 8 feet. Stockpile in a manner to prevent erosion.

3.03 UNSUITABLE MATERIAL

A Undercut, remove, and replace material which Engineer designates as unsuitable for subsequent construction.

B Material used to replace unsuitable material shall be suitable material from site excavation or as indicated on Plans.

3.04 EXCAVATION AND FILL

A Construction surveying shall be performed by qualified personnel under the direction of the contractor. Contractor shall be responsible for the accuracy and correctness of this work. In the event that the work consists of significant alteration of the topographic features of natural grade, contractor shall perform enough topographic survey to substantiate existing pre-construction elevations. No claim shall be made for additional excavation or grade adjustment in excess of quantities contained in the contract documents without demonstrable evidence that such conditions existed prior to start of the work

B Depressed site areas shall be filled using material from high areas, insofar as practicable.

C When fill obtained from high areas is exhausted, fill to indicated rough grade elevations under roadways with “Structural Fill" and open areas not under structures or roadways with “General Fill”, or as indicated on Plans.

D Place and compact fill in accordance with Section 02330 – Embankment.

3.05 SALVAGEABLE ITEMS AND MATERIAL

A Items designated by Engineer to be salvaged are to be carefully removed, so as to cause no damage to the salvaged items and delivered to Owner’s storage yard.

3.06 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

END OF SECTION

Section 02220

SITE DEMOLITION

1.0 GENERAL

1.01 SECTION INCLUDES

A Demolishing and removing existing pavements, structures, equipment and materials only to the extent as indicated on the Plans.

B Removing concrete paving, asphaltic concrete pavement, and base courses.

C Removing concrete curbs, concrete curb and gutters, sidewalks and driveways.

D Removing pipe culverts and sewers.

E Removing miscellaneous structures of wood, plastics, metals, concrete, masonry, or combination of concrete and masonry, etc.

F Disposing of demolished materials and equipment.

G References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01500 – Temporary Facilities and Control
4. Section 01100 – Summary of Work
5. Section 01730 – Cutting and Patching
6. Section 01140 – Contractor's Use of Premises
7. Section 01562 – Waste Material Disposal

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for removing and disposing of existing pavement and structures under this Section. Include cost for removing and disposing of existing pavement and structures in Bid Items for which this Work is a component.

B If indicated as a Bid Item, measurement will be as follows:
1. Measurement for removing and disposing of concrete base and surfacing, and removing asphaltic surfacing, is on a square yard basis measured between lips of gutters.
2. Measurement for removing and disposing of cement stabilized shell base course, with or without asphalt surfacing, is on a square yard basis.
3. Measurement for removing and disposing of concrete base and surfacing with curbs, is on a square yard basis measured from back to back of curbs. Payment includes removal of all base, asphaltic surfacing, concrete pavement, esplanade curbs, curb and gutters, and paving headers.

4. Measurement for removing and disposing of concrete pavement is on a square yard basis measured from back to back of curbs.
5. Measurement for removing and disposing of monolithic curb and gutter, removing monolithic concrete curb, and removing concrete curb, is on a lineal foot basis measured along the face of the curb.
6. Measurement for removing and disposing of concrete sidewalk and driveway is on a square yard basis.
7. Measurement for removing and disposing of miscellaneous concrete and masonry removal is on a cubic yard basis of the structure in place.
8. Measurement for removing and disposing of pipe culverts and sewers is on a lineal foot basis for each diameter of type of pipe removed.
9. Measurement for removing and disposing of unlisted materials shall be on the lump sum basis.

C No payment will be made for work outside maximum payment limits indicated on Plans, or in areas removed for Contractor's convenience.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit proposed methods, equipment, materials and sequence of operations for demolition. Describe coordination for shutting off, capping, and removing temporary utilities. Plan operations to minimize temporary disruption of utilities to existing facilities or adjacent property.

C Submit proposed demolition and removal schedule for approval. Notify Engineer in writing at least 48 hours before starting demolition.

D Submit an approved copy of demolition schedule to Engineer prior to commencement of demolition operations.

E Obtain a permit for building demolition, as required.

1.04 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

B The Contractor shall be responsible for safety and integrity of adjacent structures and shall be liable for any damage due to movement or settlement. Provide proper framing and shoring necessary for support. Cease operations if an adjacent structure appears to be endangered. Resume demolition only after proper protective measures have been taken.

1.05 OWNERSHIP OF MATERIAL AND EQUIPMENT

A Materials and equipment designated for reuse or salvage are listed in Section 01100 – Summary of Work. Protect items designated for reuse or salvage from damage during demolition, handling and storage. Restore damaged items to satisfactory condition.

B Materials and equipment not designated for reuse or salvage become the property of the Contractor.

1.06 STORAGE AND HANDLING

A Store and protect materials and equipment designated for reuse until time of installation.

B Deliver and unload items to be salvaged to storage areas indicated on Plans.

C Remove equipment and materials not designated for reuse or salvage and all waste and debris resulting from demolition from site. Remove material as work progresses to avoid clutter.

2.0 PRODUCTS

2.01 EQUIPMENT AND MATERIALS FOR DEMOLITION

A Use equipment and materials approved as prescribed in this Section, 1.03 "Submittals'.

B Use of a "drop hammer" must have the Engineer's prior approval.

3.0 EXECUTION

3.01 EXAMINATION

A Prior to demolition, make an inspection with Engineer to determine the condition of existing structures and features adjacent to items designated for demolition.

B Engineer will mark or list existing equipment to remain the property of the Owner.

C Do not proceed with demolition or removal operations until after the joint inspection and subsequent authorization by Engineer.

D Stop demolition and notify Engineer if underground fuel storage tanks, asbestos, PCB's, contaminated soils, or other hazardous materials are encountered.

3.02 UTILITY SERVICES

A Follow rules and regulations of authorities or companies having jurisdiction over communications, pipelines, and electrical distribution services.

B Notify and coordinate with utility company and adjacent building occupants when temporary interruption of utility service is necessary.

C When required by the Work, cutting, patching, and fitting of Work to existing facilities, accommodating installation or connection of Work with existing facilities, or uncovering Work for access, inspection, or testing shall be performed in accordance with Section 01730 – Cutting and Patching

3.03 MECHANICAL WORK ITEMS

A Mechanical removals consist of dismantling and removing existing piping, pumps, motors, water tanks, equipment and other appurtenances. It includes cutting, capping, and plugging required to restore use of existing utilities.

B Remove existing process, water, chemical, gas, fuel oil and other piping not required for new work. Take out piping to the limits shown or to a point where it will not interfere with the new work. Piping not indicated to be removed or which does not interfere with new work shall be removed to the nearest solid support, capped, and the remainder left in place. Purge chemical and fuel lines and tanks. Verify that such lines are safe prior to removal or capping.

C Where piping that is to be removed passes through existing walls, cut and cap piping on each side of the wall. Use cap appropriate for pipe material to be capped. Provide fire-rated sealant for walls classified as fire-rated.

D When underground piping, which is not located in the public right-of-way, is to be altered or removed, cap the remaining piping. Abandoned underground piping may be left in place unless it interferes with new work or is shown or specified to be removed. Piping less than 15 inches in diameter may be plugged and abandoned in place. For piping 15 inches in diameter and greater to be abandoned, fill with sand, pressure grout or other approved method and plug with concrete or brick masonry bulkhead.

E Remove waste and vent piping to points shown. Plug pipe and cleanouts and plugs. Where vent stacks pass through an existing roof that is to remain, remove the stack and patch the hole in the roof, making it watertight. Comply with requirements of existing roof installer so as to maintain roof warranty.

F Conform to applicable codes when making any changes to plumbing and heating systems.

3.04 ELECTRICAL WORK ITEMS

A Electrical removals consist of disconnecting and removing existing switchgear, distribution switchboards, control panels, bus duct, conduits and wires, panel boards, lighting fixtures, and miscellaneous electrical equipment.

B Remove existing electrical equipment and fixtures to prevent damage to allow continued operation of existing systems and to maintain the integrity of the grounding systems.

C Remove poles and metering equipment, if designated for removal on the Plans. Coordinate electrical removals with the power company, as necessary. Verify that power is properly de-energized and disconnected.

D Where shown or otherwise required, remove wiring in underground duct systems. Verify function of wiring before disconnecting and removing. Plug ducts which are not to be reused at entry to buildings.

E Changes to electrical systems shall conform to applicable codes.

3.05 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

B Remove from the site all items contained in or upon the structure not designated for reuse or salvage in accordance with this Section and Section 01562 – Waste Material Disposal.

C Follow method of disposal as required by regulatory agencies.

END OF SECTION

Section 02252

CEMENT STABILIZED SAND

1.0 GENERAL

1.01 SECTION INCLUDES

A Cement stabilized sand for backfill and bedding.

B References to Technical Specifications:
1. Section 01350 – Submittals
2. Section 02255 – Bedding, Backfill, and Embankment Materials
3. Section 01450 – Testing Laboratory Services

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 558, "Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures"
   b. ASTM D 1632, "Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory"
   c. ASTM D 1633, "Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders"
   d. ASTM C 150, "Standard Specification for Portland Cement"
   e. ASTM C 33, "Standard Specification for Concrete Aggregates"
   f. ASTM D 2487, "Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)"
   g. ASTM C 142, "Standard Test Method for Clay Lumps and Friable Particles in Aggregates"
   h. ASTM C 123, "Standard Test Method for Lightweight Particles in Aggregate"
   i. ASTM C 40, "Standard Test Method for Organic Impurities in Fine Aggregates for Concrete"
   j. ASTM C 4318, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
   k. ASTM C 94, "Standard Specification for Ready-Mixed Concrete"
   l. ASTM C 31, "Standard Practice for Making and Curing Concrete Test Specimens in the Field"

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as an Extra Item, no separate payment will be made for cement stabilized sand under this Section. Include cost in Bid Items for applicable utility or structure installation.

B If use of cement stabilized sand is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a per ton basis. A conversion between volumes calculated based on theoretical limits and total weight will be made based on a ratio of 1.64 tons per cubic yard.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit material qualification and design mix tests to include:

1. Three series of tests of sand or fine aggregate material from the proposed source. Tests shall include procedures defined in this Section, 2.01 "Materials".
2. Three moisture-density relationship tests prepared using the material qualified by the tests in this Section, 1.03B1. Blends of fine aggregate from crushed concrete and bank run sand shall be tested at the ratio to be used for the design mix testing.
3. Design mix report to meet the specifications of this Section, 1.04 "Design Requirements". The design mix shall include compressive strength tests after 48-hours and 7 days curing.

1.04 DESIGN REQUIREMENTS

A Design sand-cement mixture to produce a minimum unconfined compressive strength of 100 pounds per square inch in 48 hours when compacted to a minimum 95 percent in accordance with ASTM D 558 and when cured in accordance with ASTM D 1632, and tested in accordance with ASTM D 1633. Mix shall contain a minimum of 1-1/2 sacks of cement per cubic yard. Compact mix with a moisture content on the dry side of optimum.

2.0 PRODUCTS

2.01 MATERIALS

A Cement shall be Type 1 Portland cement conforming to ASTM C 150.

B Sand shall be clean, durable, and meet grading requirements for fine aggregates of ASTM C 33 and the following requirements:

1. Classified as SW, SP or SM by the United Soil Classification System of ASTM D 2487.
2. Deleterious material content:
   a. Clay lumps shall comprise less than 0.5 percent by ASTM C 142.
   b. Lightweight pieces shall comprise less than 5.0 percent by ASTM C 123.
   c. Organic impurities shall produce color no darker than the standard color by ASTM C 40 ASTM.
3. Plasticity index of 4 or less when tested in accordance with ASTM D 4318.

C Fine aggregate, manufactured from crushed concrete meeting the quality requirements for crushed rock material in Section 02255 - Bedding, Backfill, and Embankment Materials, may be used as a complete or partial substitute for Bank Sand. The blending ratio of fine aggregate from crushed concrete and Bank Sand shall be defined in the mix design report.

D Water shall be potable, free of oils, acids, alkalies, organic matter, or other deleterious substances, meeting requirements of ASTM C 94.

2.02 MIXING MATERIALS

A Thoroughly mix sand, cement and water in proportions of the mix design using a pugmill-type mixer. The plant shall be equipped with automatic weight controls to ensure correct mix proportions.

B Stamp batch ticket at plant with time of loading directly after mixing. Material not placed and compacted within 4 hours after mixing shall be rejected.

3.0 EXECUTION

3.01 PLACEMENT AND COMPACTION

A Place sand-cement mixture in 8-inch-thick loose lifts and compact to a minimum of 95 percent of ASTM D 558, unless otherwise specified on Plans. The moisture content during compaction shall be on the dry side of optimum but sufficient for hydration. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at the plant.

B Do not place or compact sand-cement mixture in standing or free water.

3.02 FIELD QUALITY CONTROL

A Testing will be performed under provisions of Section 01450 - Testing Laboratory Services.

B Mixing plant inspections will be performed periodically. Material samples will be obtained and tested in accordance with this Section, 2.01 “Materials”, if there is evidence of change in material characteristic.

C One sample of cement stabilized sand shall be obtained for each 150 tons of material placed per day with no less than one sample per day of production. Random samples of delivered cement stabilized sand shall be taken in the field at point of delivery in accordance with ASTM 3665. Obtain three individual samples of approximately 12 to 15 lb each from the first, middle, and last third of the truck and composite them into one sample for test purpose.

D Prepare and mold four specimens (for each sample obtained) in accordance with ASTM D558, Method A, without adjusting moisture content. Samples will be molded at approximately same time material is being used, but no later than 4 hours after water is added to mix.

E After molding, specimens will be removed from molds and cured in accordance with ASTM D 1632.

F Specimens will be tested for compressive strength in accordance with ASTM D 1633, Method A. Two specimens will be tested at 48 hours plus or minus 2 hours and two specimens will be tested at 7 days plus or minus 4 hours.

G A strength test will be average of strengths of two specimens molded from same sample of material and tested at same age. Average daily strength will be average of strengths of all specimens molded during one day's production and tested at same age.

H Precision and Bias: Test results shall meet recommended guideline for precision in ASTM D 1633 Section 9.

I Reporting: Test reports shall contain, as a minimum, the following information:

1. Supplier and plant number
2. Time material was batched
3. Time material was sampled
4. Test age (exact hours)
5. Average 48-hour strength
6. Average 7-day strength
7. Specification section number
8. Indication of compliance / non-compliance
9. Mixture identification
10. Truck and ticket numbers
11. The time of molding
12. Moisture content at time of molding
13. Required strength
14. Test method designations
15. Compressive strength data as required by ASTM D 1633
16. Supplier mixture identification
17. Specimen diameter and height, in.
18. Specimen cross-sectional area, sq. in.

J The cement content will be checked on samples obtained in the field whenever there are apparent changes in the mix properties.

3.03 ACCEPTANCE

A Strength level of material will be considered satisfactory if:

1. The average 48-hour strength is greater than 100 psi with no individual strength test below 70 psi.
2. All 7-day individual strength tests (average of two specimens) are greater than or equal to100 psi.

B Material will be considered deficient when 7-day individual strength test (average of two specimens) is less than 100 psi but greater than 70 psi. See Paragraph 3.04 Adjustment for Deficient Strength.

C The material will be considered unacceptable and subject to removal and replacement at Contractors expense when individual strength test (average of two specimens) has 7-day strength less than 70 psi

D When moving average of three daily 48-hour averages falls below 100 psi, discontinue shipment to project until plant is capable of producing material, which exceeds 100 psi at 48 hours. Five 48-hour strength tests shall be made in this determination with no individual strength tests less than 100 psi.

E Testing laboratory shall notify Contractor, Project Manager, and material supplier by facsimile of tests indicating results falling below specified strength requirements within 24 hours.

F If any strength test of laboratory cured specimens falls below the specified strength, Contractor may, at his own expense, request test of cores drilled from the area in question in accordance with ASTM C42. In such cases, three (3) cores shall be taken for each strength test that falls below the values given in 3.03.A.

G Cement stabilized sand in an area represented by core tests shall be considered satisfactory if the average of three (3) cores is equal to at least 100 psi and if no single core is less that 70 psi. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted.

3.04 ADJUSTMENT FOR DEFICIENT STRENGTH

A When mixture produces 7-day compressive strength greater than or equal to 100 psi, then material will be considered satisfactory and bid price will be paid in full.

B When mixture produces 7-day compressive strength less than 100 psi and greater than or equal to 70 psi, material shall be accepted contingent on credit in payment Compute credit by the following formula:

$$\text{Credit per Cubic Yard} = \frac{\$30.00 \times 2\ (100\ \text{psi} - \text{Actual psi})}{100}$$

C When mixture produces 7-day compressive strength less than 70 pounds per square inch, then remove and replace cement-sand mixture and paving and other necessary work at no cost to City.

END OF SECTION

Section 02255

BEDDING, BACKFILL, AND EMBANKMENT MATERIALS

1.0 GENERAL

1.01 SECTION INCLUDES

A A reference source for materials used as embedment, backfill, back-dressing, and embankment, specified elsewhere in the Technical Specifications, and their associated material qualification testing requirements.

B Source qualifications and handling of these materials.

C Material use and application is specified on the Plans or in individual Technical Specifications referencing materials either by Material Classification or by Product Description.

D References to Technical Specifications:
1. Section 03300 – Cast-in-Place Concrete
2. Section 02910 – Topsoil
3. Section 02252 – Cement Stabilized Sand

E Referenced Standards:
1. American Society for Testing and Materials (ASTM)
    a. ASTM D 2487, “Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)”
    b. ASTM C 142, “Standard Test Method for Clay Lumps and Friable Particles in Aggregates”
    c. ASTM C 123, “Standard Test Method for Lightweight Particles in Aggregate”
    d. ASTM C 40, “Standard Test Method for Organic Impurities in Fine Aggregates for Concrete”
    e. ASTM C 4318, “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
    f. ASTM D 1140, “Standard Test Methods for Amount of Material in Soils Finer the No. 200 (70-um) Sieve”
    g. ASTM C 33, “Standard Specification for Concrete Aggregates”
    h. ASTM C 136, “Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates”
    i. ASTM C 131, “Standard Test Methods for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”

2.0 PRODUCTS

2.01 MATERIAL CLASSIFICATIONS

A Materials shall be classified for the purpose of quality control in accordance with the Unified Soil Classification Symbols as defined in ASTM D 2487.

1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
   a. Plasticity index: non-plastic.
   b. Gradation: D_{60}/D_{10} - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.
2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines:
   a. Plasticity index: non-plastic to 4.
   b. Gradations:
      Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.
      Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
   c. Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.
3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):
   a. Plasticity index: greater than 7.
   b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.
4. Class IVA: Lean clays (CL).
   a. Plasticity Indexes:
      Plasticity index: greater than 7, and above A line.
      Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.
   b. Liquid limit: less than 50.
   c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
   d. Inorganic.
5. Class IVB: Fat clays (CH)
   a. Plasticity index: above A line.
   b. Liquid limit: 50 or greater.
   c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
   d. Inorganic.

B Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to the more restrictive class.

2.02 PRODUCT DESCRIPTIONS

A Unsuitable Material. Unsuitable soil materials are the following:

1. Materials that are classified as ML, CL-ML, MH, PT, OH and OL according to ASTM D 2487.
2. Materials that cannot be compacted to the required density due to either gradation, plasticity, or moisture content.
3. Materials that contain large clods, aggregates, stones greater than 3 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

B Suitable Material. Soil materials meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with, for example, lime or cement shall be considered suitable, unless otherwise indicated.

C General Fill. Material that is free of stones greater than 3 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to the following limits for deleterious materials:

1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C 142.
2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C 123.
3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C 40.

D Random Fill. Soils defined by ASTM D 2487 as Class I, II, III, IV, or fat clay (CH), sand, gravel, or a combination, from excavation or borrow, which can be compacted to form stable embankments, and conforming to:

1. Liquid Limit: 65 maximum, ASTM - D4318.
2. Plasticity Index: 0 minimum, 45 maximum, ASTM - D4318.
3. Free from trash, vegetation, organic matter, large stones, hard lumps of earth and frozen, corrosive or perishable material.
4. Well broken up, free of clods greater than 6 inches, hard earth, rocks, and stones greater than 2-inch dimension.

E Structural Fill. Soils defined by ASTM D 2487 as Class I, II, III, or IV, sand, gravel, or a combination, from excavation or borrow, which can be compacted to form stable embankments and fills conforming to:

1. Liquid Limit: 45 maximum, ASTM D 4318.
2. Plasticity Index: 12 minimum, 20 maximum, ASTM D 4318.
3. Free from trash, vegetation, organic matter, large stones, hard lumps of earth and frozen, corrosive or perishable material.
4. Well broken up, free of clods greater than 6 inches, hard earth, rocks, and stones greater than 2-inch dimension.

F Select Fill. Class III clayey gravel or sand or Class IV lean clay or clayey soils treated with lime or cement, and conforming to:

1. Plasticity Index: 7 minimum, 20 maximum, ASTM D 4318.
2. Free from trash, vegetation, organic matter, large stones, hard lumps of earth and frozen, corrosive or perishable material.
3. Well broken up, free of clods greater than 6 inches, hard earth, rocks, and stones greater than 2-inch dimension.

G Concrete Fill. Conform to requirements for Class B concrete as specified in Section 03300 - Cast-in-Place Concrete.

H Topsoil. Conform to requirements specified in Section 02910 - Topsoil.

I Bank Sand: Durable Bank Sand classified as SP, SW, or SM by the Unified Soil Classification System (ASTM D 2487) meeting the following requirements:

1. Less than 15 percent passing the number 200 sieve when tested in accordance with ASTM D 1140. The amount of clay lumps or balls not exceeding 2 percent.
2. Material passing the number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318:
   a. Liquid limit: not exceeding 25 percent.
   b. Plasticity index: not exceeding 7.

J Cement Stabilized Sand. Conform to requirements of Section 02252 - Cement Stabilized Sand.

K Concrete Sand. Natural sand, manufactured sand, or a combination of natural and manufactured sand conforming to the requirements of ASTM C 33 and graded within the following limits when tested in accordance with ASTM C 136:

SIEVE	PERCENT PASSING
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

L Gem Sand. Sand conforming to the requirements of ASTM C 33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C 136:

SIEVE	PERCENT PASSING
3/8"	95 to 100
No. 4	60 to 80
No. 8	15 to 40

M Pea Gravel. Durable particles composed of small, smooth, rounded stones or pebbles and graded within the following limits when tested in accordance with ASTM C 136:

SIEVE	PERCENT PASSING
1/2"	100
3/8"	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

N Crushed Aggregates. Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:

1. Materials of one product delivered for the same construction activity from a single source.
2. Non-plastic fines.
3. Los Angeles Abrasion Test wear not exceeding 45 percent when tested in accordance with ASTM C 131.
4. Crushed aggregate shall have a minimum of 90 percent of the particles retained on the No. 4 sieve with 2 or more crushed faces as determined by TxDOT Tex-460-A, Part I.
5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from a naturally occurring single source. Uncrushed gravel are not acceptable materials for embedment where crushed stone is shown on the applicable utility embedment drawing details.
6. Crushed Concrete: Crushed concrete is an acceptable substitute for crushed stone as utility backfill. Gradation and quality control test requirements are the same as crushed stone. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate), or debris.
7. Gradations, as determined in accordance with TxDOT Tex-110-E.

SIEVE	PERCENT PASSING BY WEIGHT FOR PIPE EMBEDMENT BY RANGES OF NOMINAL PIPES SIZES		
	>15"	15" - 8"	<8"
1"	95 - 100	100	-
3/4"	60 - 90	90 – 100	100
1/2"	25 - 60	-	90 – 100
3/8"	-	20 – 55	40 - 70
No. 4	0 - 5	0 – 10	0 - 15
No. 8	-	0 - 5	0 - 5

3.0 EXECUTION

3.01 SOURCE QUALIFICATIONS FOR BORROW MATERIAL

A Use of material encountered in excavations is acceptable, provided applicable requirements are satisfied. If excavation material is not acceptable, provide from other approved source.

B Identify off-site sources for materials at least 14 days ahead of intended use so that the Engineer may obtain samples for verification testing.

C Obtain approval for each material source by the Engineer before delivery is started. If sources previously approved do not produce uniform and satisfactory products, furnish materials from other approved sources. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet the requirements will be rejected. Do not use material which, after approval, has become unsuitable for use due to segregation, mixing with other materials, or by contamination. Once a material is approved by the Engineer, a Change Order is required to change to a different material.

D Bank sand, select fill, and random fill, if available in the project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete the Work from off-site sources.

E The Owner does not represent or guarantee that any soil found in the excavation work will be suitable and acceptable as backfill material.

3.02 MATERIAL HANDLING

A When material is obtained from either a commercial or non-commercial borrow pit, open the pit to expose the vertical faces of the various strata for identification and selection of approved material to be used. Excavate the selected material by vertical cuts extending through the exposed strata to achieve uniformity in the product.

B Establish temporary stockpile locations for practical material handling and control, and verification testing by the Engineer in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.

C When stockpiling material near the Project Site, use appropriate methods to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering the drainage system.

D Place material suitable for backfilling in stockpiles at a distance from the trench to prevent slides or cave-ins. Do not place stockpiles of excavated materials on public streets.

E Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

END OF SECTION

Section 02315

EXCAVATION AND BACKFILL FOR DETENTION PONDS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Excavation of materials for detention ponds.

B. Placement of fill within the project limit.

C. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01760 – Project Record Documents
4. Section 01450 – Testing Laboratory Services
5. Section 01500 – Temporary Facilities and Controls
6. Section 01562 – Waste Material Disposal
7. Section 02255 – Bedding, Backfill and Embankment Material
8. Section 01570 – Trench Safety Systems
9. Section 01564 – Control of Ground Water and Surface Water
10. Section 01720 – Field Surveying
11. Section 02220 – Site Demolition
12. Section 02200 – Site Preparation
13. Section 02330 – Embankment
14. Section 01140 – Contractor's Use of Premises

D. Referenced Standards:

1. American Society for Testing and Materials (ASTM)
   a. ASTM D 698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort"
   b. ASTM D 4318, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
   c. ASTM 1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method"
   d. ASTM 2922, "Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"
   e. ASTM 2922, "Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)"
2. Occupation Safety and Health Administration (OSHA)
3. Texas Department of Transportation (TxDOT)
   a. Tex-101-E, Preparing Soil and Flexible Base Materials for Testing.
   b. Tex-110-E, Particle Size Analysis of Soils.

E. Definitions:

1. Final Survey – the survey completed after the detention pond excavation is complete, all on site fill material has been placed, all excess fill material has been hauled off site, final grades have been completed. This survey shall be completed prior to the placement of any concrete, topsoil or installation of Bio-swales.
2. Initial Survey – the survey completed after site preparation has been completed and prior to any excavation.
3. Over-Excavation – excavation of unsatisfactory soils in the bottom and or side slopes of the detention pond as identified by the material testing lab during excavation.

1.02 MEASUREMENT AND PAYMENT

A. Measurement and payment for detention pond excavation fill placement and excess material disposal shall be on a cubic yard basis and paid for in a single pay item.

1. Payment will be made monthly based on estimated quantities up to 90% of the total bid quantity included in section 00300 – Bid Proposal. No additional payment will be made until submittal and approval of the final survey. Survey shall be in accordance with Section 01720 Field Surveying.
2. The Engineer shall calculate the final pay item quantity using the Initial and Final Surveys. Payment will be based on the calculated volume of material excavated from the pond. No separate payment is made for fill material placed either inside or outside the project boundaries. Contractor shall not be paid for excavation quantities below the grades or outside of the limits of established bank as shown on the plans. The Engineers calculated quantities shall be final.

B. Measurement and Payment for Over-Excavation and Backfill of Unsuitable Materials shall be on a cubic yard basis. All Over-Excavation must be approved by the Engineer prior to work being done, in order to be paid. Quantities to be over excavated shall be agreed to by the Contractor and Owners Representative on a daily basis.

C. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Initial Survey, Signed and Sealed by a Texas Licensed Land Surveyor on a maximum grid of 25’. A hard copy and electronic file capable of creating a digital terrain model shall be submitted.

C. Final Survey, Signed and Sealed by a Texas Licensed Land Surveyor on a maximum grid of 25’. A hard copy and electronic file capable of creating a digital terrain model shall be submitted.

D. Submit record drawings documenting locations of grade breaks and swales, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of approved Over- Excavation and back fill. Give horizontal dimensions, elevations, inverts and gradients.

1.04 TESTING

A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A. Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 MATERIALS

A. Contractor shall use on-site materials for backfill that conforms to the requirements in Section 02255 – Bedding, Backfill and Embankment Material.

2.02 EQUIPMENT

A. Perform excavation with equipment suitable for achieving the requirements of this section.

B. Use equipment which will produce the degree of compaction specified.

3.0 EXECUTION

3.01 PREPARATION

A. Construction surveying shall be performed by qualified personnel under the direction of the contractor. Contractor shall be responsible for the accuracy and correctness of this work. In the event that the work consists of significant alteration of the

topographic features of natural grade, contractor shall perform enough topographic survey to substantiate existing pre-construction elevations. No claim shall be made for additional excavation or grade adjustment in excess of quantities contained in the contract documents without demonstrable evidence that such conditions existed prior to start of the work

B. Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety Systems.

C. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.

D. Identify required lines, levels, and datum. Coordinate with Section 01720 – Field Surveying.

E. Perform the Initial Survey in accordance with this Specification and Section 01720- Field Surveying.

F. Identify existing structures and utilities above and below grade. Stake and flag their location.

G. Remove existing pavements and structures, including sidewalks and driveways, in conformance with requirements of Section 02220 – Site Demolition, as applicable.

H. Area shall be cleared and grubbed under the provisions of Section 02200 – Site Preparation prior to excavation.

I. Strip and stockpile topsoil under the provisions of Section 02200 – Site Preparation. Ensure strip material to be used a topsoil meets criteria in Section 02910- Topsoil and is kept separated from unsuitable material.

J. Upon discovery of unknown or badly deteriorated utilities not designed for removal, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

3.02 EXCAVATION

A. Perform excavation work to an elevation that shall allow the finished grades as shown on the plans. Some areas shown on the plans include 3" of top soils and some the finished grade areas do not include the placement of top soil. If the top soil is not included in the finished grade, the top soil is part of a separate contract and shall be done by others.

B. Excavated soil shall be classified as suitable or unsuitable backfill. Any soils deemed unsuitable for backfill shall be hauled off site. Material suitable for backfill shall be stockpiled until no longer needed and then disposed of.

C. If when the Contractor reaches the required elevation and finds the subgrade soil to be of questionable quality, the Contractor shall notify the Engineer and request the Owner's laboratory to test the soil. If the laboratory finds the soil to be unsuitable, the Contractor shall Over-Excavate the unsuitable soil and replace with on-site material that meets the Clay-Liner material requirements. The Contractor shall coordinate the Over-Excavation with the Owner's Representative and Laboratory to ensure all unsuitable material is removed and the quantity of unsuitable material is properly recorded for payment.

D. While waiting for lab results for unsuitable soil, Contractor may continue excavation in other parts of the Detention Pond, after the area of concern has been staked out.

E. Prior to Final Grading the Contractor shall install any underground utilities to ensure the subgrade material is suitable. The excavation of the underground utilities shall be in accordance with Section 02318 – Excavation and Backfill for Utilities.

F. After Final Grading the Contractor shall perform and submit the Final Survey in accordance with Section 01720 – Field Surveying.

3.03 DEWATERING

A. Maintain ground water control as directed by Section 01564 – Control of Ground Water and Surface Water. No separate payment shall be made for dewatering associated with work.

3.04 FIELD QUALITY CONTROL

A. Tests will be performed initially on a minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with TxDOT Tex 101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.

B. In-place density tests of compacted subgrade will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at the following frequencies and conditions.
   1. A minimum of three density tests for each full work shift when compaction is being performed.
   2. Density tests will be performed in all placement areas.
   3. The number of tests will be increased in inspection determines that soils types or moisture contents are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density

C. At least three tests for moisture-density relationships will be initially performed for each type of backfill material in accordance with ASTM D 698. Additional

moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.

D. If tests indicate work does not meet specified compaction requirements, recondition, re-compact, and retest at Contractor's expense.

3.05 CLEAN-UP AND RESTORATION

A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 - Contractor's Use of Premises.

3.06 PROTECTION OF THE WORK

A. Maintain excavation and embankment areas until start of subsequent work. Repair and re-compact slides, washouts, settlements, or areas with loss of density at no cost to the Owner.

B. Prevent erosion at all times and maintain slopes until vegetation has been established.

END OF SECTION

Section 02316

EXCAVATION AND BACKFILL FOR ROADWAYS

1.1 GENERAL

1.2 SECTION INCLUDES

A. Excavation of materials for roadways.

B. Excavation of materials for roadside ditches.

C. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01760 – Project Record Documents
4. Section 01450 – Testing Laboratory Services
5. Section 01500 – Temporary Facilities and Controls
6. Section 02255 – Bedding, Backfill and Embankment Material
7. Section 01570 – Trench Safety Systems
8. Section 01564 – Control of Ground Water and Surface Water
9. Section 01720 – Field Surveying
10. Section 02220 – Site Demolition
11. Section 02200 – Site Preparation
12. Section 02330 – Embankment
13. Section 01140 – Contractor's Use of Premises

D. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM D 698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort"
b. ASTM D 1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method"
c. ASTM D 2922, "Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"
d. ASTM D 3017, "Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)"

1.3 MEASUREMENT AND PAYMENT

A. Measurement shall be by the cubic yard measured in place, including labor, equipment, tools and incidentals necessary to complete the work.

B. Payment includes control of ground water and surface water, trench safety systems, removal of existing pavements and structures, repair and maintenance of excavated or backfilled areas, and other measures specified in this Section and not included in payment elsewhere.

C. Refer to Section 01200 – Measurement and Payment Procedures.

D. No payment will be made for material excavated under the following conditions:

1. More than 2 feet outside of vertical planes behind back of curbs.
2. For portion within limits of trench for utilities constructed by open-cut methods.
3. As indicated otherwise on Drawings.

E. Construction Surveying shall be performed by qualified personnel under the direction of the Contractor. Contractor shall be responsible for the accuracy and correctness of this work. In the event that the Work consists of significant alteration of the topographic features of natural grade, Contractor shall perform enough topographic survey to substantiate existing pre-construction elevations. No claim shall be made for additional excavation or grade adjustment in excess of quantities contained in the contract documents without demonstrable evidence that such conditions existed prior to start of the Work.

F. Excavation and Backfill quantities that exceed the construction plans shall be substantiated with topographic survey of finished grade by survey (RPLS) and verified by the Engineer at contractor's expense.

1.4 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit product quality, material sources, and field quality information in accordance with this Section.

C. Submit field red lines documenting location of roadway excavation as installed, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.5 TESTING

A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.6 PROTECTION OF PEOPLE AND PROPERTY

A. Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.1 PRODUCTS

2.2 MATERIALS

A. Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.

3.1 EXECUTION

3.2 PREPARATION

A. Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety Systems.

B. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.

C. Identify required lines, levels, and datum. Coordinate with Section 01720 – Field Surveying.

D. Identify existing structures and utilities above and below grade. Stake and flag their location.

E. Remove existing pavements and structures, including sidewalks and driveways, in conformance with requirements of Section 02220 – Site Demolition, asapplicable.

F. Area shall be cleared and grubbed under the provisions of Section 02200 – Site Preparation prior to excavation.

G. Strip and stockpile topsoil under the provisions of Section 02200 – SitePreparation.

H. Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

3.3 EXCAVATION

A. Excavate to lines and grades shown on Plans.

B. Areas of unsuitable material shall be removed, backfilled with embankment materials, and compacted under the provisions of Section 02330 – Embankment.

C. At intersections, grade back at minimum slope of one inch per foot. Produce a smooth riding junction with intersecting street. Maintain proper drainage.

D. Fill over-excavated areas in accordance with requirements of Section 02330 – Embankment at no cost to the Owner.

3.4 COMPACTION REQUIREMENTS

A. Maintain moisture content of embankment materials to attain required compaction density.

B. Compact to minimum densities at moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on the Drawings.

1. Areas under future paving and shoulders: Minimum density of 95 percent of maximum dry density.
2. Other areas: Minimum density of 90 percent of maximum dry density.

3.5 TOLERANCES

A. Top of compacted surface: Plus or minus 1/2 inch in cross section, or in 16 foot length.

3.6 FIELD QUALITY CONTROL

A. Compaction Testing will be performed in accordance with ASTM D 1556 or ASTM D 2922 and ASTM D 3017 under provisions of Section 01450 – Testing Laboratory Services.

B. Three or more tests, at Engineer's/Owner's option, will be taken for each 1,000 linear feet per lane of roadway or 500 square yards of embankment per lift.

C. If tests indicate work does not meet specified compaction requirements, recondition, re-compact, and retest at Contractor's expense.

3.7 CLEAN-UP AND RESTORATION

A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 - Contractor's Use of Premises.

B. In unpaved areas, grade surface as a uniform slope from installed appurtenances to natural grade and stabilize as indicated on Plans.

3.8 PROTECTION OF THE WORK

A. Maintain excavation and embankment areas until start of subsequent work. Repair and re-compact slides, washouts, settlements, or areas with loss of density at no cost to the Owner

B. Prevent erosion at all times. Maintain ditches and cut temporary swales to allow natural drainage in order to avoid damage to roadway. Do not allow water to pond in excavations.

C. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

END OF SECTION

Section 02317

EXCAVATION AND BACKFILL FOR STRUCTURES

1.0 GENERAL

1.01 SECTION INCLUDES

A Excavation, backfilling, and compaction of backfill for structures.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 - Submittals
3. Section 01760 – Project Record Documents
4. Section 01450 - Testing Laboratory Services
5. Section 01500 – Temporary Facilities and Controls
6. Section 02255 – Bedding, Backfill, and Embankment Materials
7. Section 01570 - Trench Safety System
8. Section 01564 - Control of Ground Water and Surface Water
9. Section 02220 - Site Demolition
10. Section 02200 – Site Preparation
11. Section 02252 - Cement Stabilized Sand
12. Section 01562 - Waste Material Disposal

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”
   b. ASTM D 4318, “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
   c. ASTM D 1556, “Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method”
   d. ASTM D 2922, “Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)”
   e. ASTM D 3017, “Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)”
2. Occupational Safety and Health Administration (OSHA)
3. Texas Department of Transportation (TxDOT)
   a. Tex-101-E, Preparing Soil and Flexible Base Materials for Testing
   b. Tex-110-E, Particle Size Analysis of Soils

D Definitions:
1. Backfill - material meeting specified quality requirements, placed and compacted under controlled conditions around pavements, structures and utilities.

2. Foundation Backfill - natural soil or manufactured aggregate meeting Class I requirements and Geotextile fabrics as required to control drainage and material separation placed and compacted where needed to provide stable support for the structure foundation base. Foundation backfill may include crushed aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab.
3. Foundation Base - provides a smooth, level working surface for the construction of the concrete foundation.
4. Foundation Subgrade - the surface of the natural soil which has been excavated and prepared to support the foundation base or foundation backfill, where needed.
5. Over-Excavation - excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below the foundation as shown on the Plans.

1.02 MEASUREMENT AND PAYMENT UNIT PRICES

A Unless indicated as a Bid Item, no separate payment will be made for Excavation and Backfill for Structures under this Section. Include cost in Bid Items for construction of structures.

B If Excavation and Backfill for Structures is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit for each structure a work plan for excavation and backfill with a complete written description which identifies details of the proposed method of construction and the sequence of operations for construction relative to excavation and backfill activities. The descriptions, with supporting illustrations, shall be sufficiently detailed to demonstrate to the Engineer that the procedures meet the requirements of the Plans and Technical Specifications.

C Submit product quality, material sources, and field quality information in accordance with this Section.

D Submit field red lines documenting location of structures as installed, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.04 TESTING

A Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 - Testing Laboratory Services and as specified in this Section.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 - Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 MATERIALS

A Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.

2.02 EQUIPMENT

A Perform excavation with equipment suitable for achieving the requirements of this Section.

B Use equipment which will produce the degree of compaction specified. Backfill within 3 feet of walls shall be compacted with hand operated equipment. Do not use equipment weighing more than 10,000 pounds closer to walls than a horizontal distance equal to the depth of the fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

3.0 EXECUTION

3.01 PREPARATION

A Employ a Trench Safety Plan as specified in Section 01570 - Trench Safety Systems.

B Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 - Control of Ground Water and Surface Water.

C Remove existing pavements and structures, including sidewalks and driveways, in accordance with requirements of Section 02220 - Site Demolition, as applicable.

D Area shall be cleared and grubbed under the provisions of Section 02200 - Site Preparation prior to excavation.

E Strip and stockpile topsoil under the provisions of Section 02200 - Site Preparation

F Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

3.02 EXCAVATION

A Perform excavation work so that the underground structure can be installed to depths and alignments shown on Plans Drawings. Use caution during excavation work to avoid disturbing surrounding ground and existing facilities and improvements. Keep excavation to the absolute minimum necessary. No additional payment will be made for excess excavation not authorized by Engineer.

B Avoid settlement of surrounding soil due to equipment operations, excavation procedures, vibration, dewatering, or other construction methods.

C Prevent voids from forming outside of sheeting. Immediately fill voids with grout, concrete fill, cement stabilized sand, or other material approved by Engineer.

D After completion of the structure, remove sheeting, shoring, and bracing unless Engineer has approved in writing that such temporary structures may remain. Remove sheeting, shoring, and bracing in such a manner as to maintain safety during backfilling operations and to prevent damage to the Work and adjacent structures or improvements.

E Immediately fill and compact voids left or caused by removal of sheeting with cement stabilized sand or material approved by Engineer.

3.03 DEWATERING

A Maintain ground water control as directed by Section 01564 - Control of Ground Water and Surface Water and until the structure is sufficiently complete to provide the required weight to resist hydrostatic uplift with a minimum safety factor of 1.2.

B Maintain the ground water surface a minimum of two feet below the bottom of the foundation base.

3.04 FOUNDATION EXCAVATION

A Notify Engineer at least 48 hours prior to planned completion of foundation excavations. Do not place the foundation base until the excavation is accepted by the Engineer.

B Excavate to elevations shown on Plans Drawings, as needed to provide space for the foundation base, forming a level undisturbed surface, free of mud or soft material. Remove pockets of soft or otherwise unstable soils and replace with foundation backfill material or a material as directed by the Engineer. Prior to placing material

over it, re-compact the subgrade, scarifying as needed, to 95 percent of the maximum Standard Proctor Density according to ASTM D 698. If the specified level of compaction cannot be achieved, moisture condition the subgrade and re-compact until 95 percent is achieved, over-excavate to provide a minimum layer of 24 inches of foundation backfill material, or other means acceptable to the Engineer.

C Fill unauthorized excessive excavation with foundation backfill material or other material as directed by the Engineer.

D Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in a satisfactory, undisturbed condition. Keep excavations free of standing water and completely free of water during concrete placement.

E Soils which become unsuitable due to inadequate dewatering or other causes, after initial excavation to the required subgrade, shall be removed and replaced with foundation backfill material, as directed by Engineer, at no additional cost to the Owner.

F Place foundation base, or foundation backfill material where needed, over the subgrade on same day that excavation is completed to final grade. Where base of excavations are left open for longer periods, protect them with a seal slab or cement-stabilized sand.

G Where directed by the Plans Drawings, all crushed aggregate, and other free draining Class I materials, shall have a Geo- textile filter fabric separating it from native soils or select material backfill. The fabric shall overlap a minimum of 12 inches beyond where another material stops contact with the soil.

H Crushed aggregate, and other Class I materials, shall be placed in uniform layers of 8-inch maximum thickness. Compaction shall be by means of at least two passes of a vibratory compactor.

3.05 FOUNDATION BASE

A After the subgrade is properly prepared, including the placement of foundation backfill where needed, the foundation base shall be placed. The foundation base shall consist of a 12-inch layer of crushed aggregate or cement stabilized sand. Alternately, a 4-inch minimum seal slab may be placed. The foundation base shall extend a minimum of 12 inches beyond the edge of the structure foundation.

B Where the foundation base and foundation backfill are of the same material, both can be placed in one operation.

3.06 BACKFILL

A Complete backfill to surface of natural ground or to lines and grades shown on Plans Drawings. Use existing material that qualifies as select material, unless indicated otherwise. Deposit backfill in uniform layers and compact each layer as specified.

B Do not place backfill against concrete walls or similar structures until laboratory test breaks indicate that the concrete has reached a minimum of 85 percent of the specified compressive strength. Where walls are supported by slabs or intermediate walls, do not begin backfill operations until the slab or intermediate walls have been placed and concrete has attained sufficient strength.

C Remove concrete forms before starting backfill and remove shoring and bracing as work progresses.

D Maintain fill material at no less than 2 percent below and no more than 2 percent above optimum moisture content. Place fill material in uniform 8-inch maximum loose layers. Compaction of fill shall be to at least 95 percent of the maximum Standard Proctor Density according to ASTM D 698 under paved areas. Compact to at least 90 percent around structures below unpaved areas.

E Where backfill is placed against a sloped excavation surface, run compaction equipment across the boundary of the cut slope and backfill to form a compacted slope surface for placement of the next layer of backfill.

F Place backfill using cement stabilized sand in accordance with Section 02252 - Cement Stabilized Sand.

3.07 FIELD QUALITY CONTROL

A Tests will be performed initially on minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with TxDOT Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.

B In-place density tests of compacted subgrade and backfill will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at the following frequencies and conditions:

1. A minimum of one test for every 100 cubic yards of compacted backfill material.
2. A minimum three density tests for each full work shift.
3. Density tests will be performed in all placement areas.
4. The number of tests will be increased if inspection determines that soil types or moisture contents are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density.

C At least three tests for moisture-density relationships will be initially performed for each type of backfill material in accordance with ASTM D 698. Additional moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.

D If tests indicate work does not meet specified compaction requirements, recondition, re-compact, and retest at Contractor's expense.

3.08 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 - Contractor’s Use of Premises.

B In unpaved areas, grade surface as a uniform slope from installed appurtenances to natural grade and stabilize as indicated on Plans.

3.09 PROTECTION OF THE WORK

A Maintain excavation and embankment areas until start of subsequent work. Repair and re-compact slides, washouts, settlements, or areas with loss of density at no cost to the Owner

B Prevent erosion at all times. Do not allow water to pond in excavations.

C Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

END OF SECTION

Section 02318

EXCAVATION AND BACKFILL FOR UTILITIES

1.0 GENERAL

1.01 SECTION INCLUDES

A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, storm sewers including manholes, pipeline structures and other associated appurtenances.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01570 – Trench Safety System
4. Section 01564 – Control of Ground Water and Surface Water
5. Section 01760 – Project Record Documents
6. Section 01450 – Testing Laboratory Services
7. Section 01500 – Temporary Facilities and Controls
8. Section 02255 – Bedding, Backfill, and Embankment Materials
9. Section 02370 – Geotextile
10. Section 02220 – Site Demolition
11. Section 01140 – Contractor's Use of Premises

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM D 2321, "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications"
b. ASTM D 698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort"
c. ASTM D 558, "Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures"
d. ASTM D 4318, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
e. ASTM D 1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method"
f. ASTM D 2922, "Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"
g. ASTM D 3017, "Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)"

2. Texas Department of Transportation (TxDOT)

   a. Tex-101-E, Preparing Soil and Flexible Base Materials for Testing
   b. Tex-110-E, Particle Size Analysis of Soils

D. Definitions:

1. Excavation - Any man-made cut, cavity, trench, or depression in an earth surface, formed by removal of material.

   a. Extra Hand Excavation- excavation by manual labor at locations designated by the Engineer, which is not included in other Bid Items.

   b. Extra Machine Excavation- excavation by machine at locations designated by the Engineer, which is not included in other Bid Items.

   c. Special Excavation-excavation necessitated by obstruction of pipes, ducts, or other structures, not shown on Plans, which interfere with installation of utility piping by normal methods of excavation or augering. Contractor shall be responsible for locating such underground obstructions, sufficiently in advance of trench excavation or augering, to preclude damage to the obstructions.

2. Pipe Foundation - suitable and stable native soils that are exposed at the trench subgrade after excavation to depth of bottom of the bedding as shown on the Plans, or foundation backfill material placed and compacted in over-excavations.

3. Pipe Bedding - the portion of trench backfill that extends vertically from top of foundation up to a level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.

4. Haunching - the material placed on either side of pipe from top of bedding up to spring-line of pipe and horizontally from one trench sidewall to opposite sidewall.

5. Initial Backfill - the portion of trench backfill that extends vertically from spring-line of pipe (top of haunching) up to a level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.

6. Pipe Embedment - the portion of trench backfill that consists of bedding, haunching, and initial backfill.

7. Trench Zone - the portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.

8. Trench Conditions - description of the stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.

    a. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as a result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.

    b. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.

        1) Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.

        2) Stable Wet Trench in Sandy Soils: Excavation drainage is provided in the embedment zone in combination with ground water control in predominately sandy or silty soils.

    c. Unstable Trench: Unstable trench conditions exist in the pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.

9. Sub-trench - a special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of a sub-trench depends upon trench stability and safety as determined by the Contractor.

10. Trench Dam - a placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along the trench.

11. Over-Excavation and Backfill - excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Plans, and backfilled with foundation backfill material.

12. Foundation Backfill Materials - natural soil or manufactured aggregate of controlled gradation, and geo-textile filter fabrics as required, to control

drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.

13. Trench Shield (Trench Box) - a portable worker safety structure moved along the trench as work proceeds, used as a Protective System and designed to withstand forces imposed on it by cave-in, thereby protecting persons within the trench. Trench shields may be stacked if so designed or placed in a series depending on depth and length of excavation to be protected.

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for trench excavation, embedment, and backfill under this Section. Include cost in Bid Items for all excavation and backfill associated with the placement and construction of: underground piping, boxes, manholes and associated appurtenances including conduit, or duct work.

B. If Special Excavation is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a cubic yard basis, measured in place, without deduction for space occupied by portions of pipes, ducts, or other structures left in place across trenches excavated under this item.

1. Payment for Special Excavation shall include:

   a. Dewatering and surface water control.
   b. Protection of pipes, ducts, or other structures encountered including bracing, shoring, and sheeting necessary for support.
   c. Replacement of pipes, ducts, or structures damaged by special excavation operations, except where payment for replacement is authorized by Engineer due to deteriorated condition of pipes, ducts, or structure.
   d. Temporary disconnecting, plugging, and reconnecting of low volume water pipes, to allow machine excavation or augering, when approved by Engineer. Pipe for replacement shall be new and conform to specification requirements for type of existing pipe removed.
   e. Placement of material from Special Excavation.
   f. Geo-textile material and concrete trench dams required to complete the placement of material from Special Excavation.
   g. Re-sodding required for surface restoration within designated limits of Special Excavation.
   h. Disposal of excess excavated material not suitable for bedding or backfill, or not required for the Work.

2. The items listed below will not be included in payment for Special Excavation. Include cost in Bid Items for which the Work is a component:

a. Trench safety system including sheeting and shoring.
b. Utility piping installed in trenches excavated under this item.
c. Removal and replacement of associated streets, driveways, and sidewalks.

C. If Extra Hand Excavation is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a cubic yard basis, measured in place.

1. Payment for Extra Hand Excavation shall include:

a. Dewatering and surface water control.
b. Disposal of excess excavated material not suitable for bedding or backfill, or not required for the Work.
c. Placement of material from Extra Hand Excavation.
d. Re-sodding required for surface restoration within designated limits of Extra Hand Excavation.

2. The items listed below will not be included in payment for Special Excavation. Include cost in Bid Items for which the Work is a component:

a. Trench safety system including sheeting and shoring.
b. Removal and replacement of associated streets, driveways, and sidewalks.

D. If Extra Machine Excavation is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a cubic yard basis, measured in place.

1. Payment for Extra Machine Excavation shall include:

a. Dewatering and surface water control.
b. Disposal of excess excavated material not suitable for bedding or backfill, or not required for the Work.
c. Placement of material from extra machine excavation.
d. Re-sodding required for surface restoration within designated limits of Extra Machine Excavation.

2. The items listed below will not be included in payment for Special Excavation. Include cost in Bid Items for which the Work is a component:

a. Trench safety system including sheeting and shoring.
b. Removal and replacement of associated streets, driveways, and sidewalks.

E. Refer to Section 01200 - Measurement and Payment Procedures. No payment will be made for delays in completion of Work resulting from Extra Item Work.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit a written description for information only of the planned typical method of excavation, backfill placement and compaction, including:

1. Sequence of work and coordination of activities.
2. Selected trench widths.
3. Procedures for foundation and embedment placement, and compaction.
4. Procedure for use of trench boxes and other pre-manufactured systems while assuring specified compaction against undisturbed soil.
5. Procedure for installation of Special Shoring at locations identified on the Plans.

C. Submit product quality, material sources, and field quality information in accordance with this Section.

D. Submit field red lines documenting location of Utilities as installed, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.04 TESTING

A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A. Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

1.06 SPECIAL SHORING DESIGN REQUIREMENTS

A. Special Shoring shall be, in accordance with Section 01570 – Trench Safety System, designed by a Professional Engineer, licensed by the State of Texas, At Contractor's expense.

B. Special Shoring shall be designed to provide support for the sides of the excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities.

C. Special Shoring may be a pre-manufactured system or a field fabricated system that meets the requirements of the Work.

2.0 PRODUCTS

2.01 MATERIALS

A. Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.

B. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in the product specification, and approved by the Engineer, provided that the physical property criteria are determined to be satisfactory by testing.

C. Geotextile (Filter Fabric): Conform to requirements of Section 02370 – Geotextile.

D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.

E. Timber Shoring Left in Place: Untreated oak.

2.02 EQUIPMENT

A. Perform excavation with track mounted excavator or other equipment suitable for achieving the requirements of this Section.

B. Use only hand-operated tamping equipment until a minimum cover of 12 inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.

C. Use trench shields or other Protective Systems or Shoring Systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.

D. Use Special Shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting the Special Shoring design requirements.

3.0 EXECUTION

3.01 PREPARATION

A. Employ a Trench Safety Program as specified in Section 01570 – Trench Safety Systems.

B. Install and operate necessary dewatering and surface water control measures conform to Section 01564 – Control of Ground Water and Surface Water.

C. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02220 – Site Demolition, as applicable.

D. Area shall be cleared and grubbed under the provisions of Section 02200 – Site Preparation prior to excavation.

E. Strip and stockpile topsoil under the provisions of Section 02200 – Site Preparation

F. Schedule work so that pipe embedment can be completed on the same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

3.02 EXCAVATION

A. Except as otherwise specified or shown on the Plans, install underground utilities in open cut trenches with vertical sides.

B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on the Plans. Avoid disturbing surrounding ground and existing facilities and improvements.

C. Determine trench excavation widths using the following schedule as related to pipe outside diameter (O.D.). Maximum trench width shall be the minimum trench width plus 24 inches.

NOMINAL PIPE SIZE, INCHES	MINIMUM TRENCH WIDTH, INCHES
Less than 18	O.D. + 18
18 to 30	O.D. + 24
Greater than 30	O.D. + 36

D. Use sufficient trench width or benches above the embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from the surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.

E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify the Engineer and obtain instructions before proceeding.

F. Shoring of Trench Walls.

1. Install Special Shoring in advance of trench excavation or simultaneously with the trench excavation, so that the soils within the full height of the trench excavation walls will remain fully laterally supported at all times.

2. For all types of shoring, support trench walls in the pipe embedment zone throughout the installation. Provide trench wall supports sufficiently tight to prevent washing the trench wall soil out from behind the trench wall support.

3. Unless otherwise directed by the Engineer, leave sheeting driven into or below the pipe embedment zone in place to preclude loss of support of foundation and embedment materials. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and the trench wall in the vicinity of the pipe zone.

4. Employ special methods for maintaining the integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.

5. If sheeting or other shoring is used below top of the pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into the embedment zone 1 inch. Fill voids left on removal of supports with compacted backfill material.

G. Use of Trench Shields. When a trench shield (trench box) is used as a worker safety device, the following requirements apply:

1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to the trench sidewalls.

2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor the degree of compaction reduced.

3. When required, place, spread, and compact pipe foundation and bedding materials beneath the shield. For backfill above bedding, move the shield as backfill is placed and ramped in. Place and compact backfill materials against undisturbed trench walls and foundation.

4. Maintain trench shield in position to allow sampling and testing to be performed in a safe manner.

3.03 TRENCH FOUNDATION

A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.

B. Place trench dams in Class I foundations in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.04 PIPE EMBEDMENT PLACEMENT AND COMPACTION

A. Immediately prior to placement of embedment materials, the bottoms and sidewalls of trenches shall be free of loose, sloughing, caving, or otherwise unsuitable soil.

B. Place Geotextile, if specified, to prevent particle migration from the in-situ into open-graded (Class I) embedment materials or drainage layers.

C. Place embedment including bedding, haunching and initial backfill to meet requirements indicated on Plans. PVC & HDPE require cement stabilized sand bedding and backfill to one foot below subgrade or below grade if under pavement, or one foot above top of pipe if not under pavement.

D. For pipe installation, manually spread embedment materials around the pipe to provide uniform bearing and side support when compacted. Do not allow materials to free-fall from heights greater than 24 inches above top of pipe. Perform placement and compaction directly against the undisturbed soils in the trench sidewalls, or against sheeting which is to remain in place.

E. Do not place trench shields or shoring within height of the embedment zone unless means to maintain the density of compacted embedment material are used. If moveable supports are used in embedment zone, lift the supports incrementally to allow placement and compaction of the material against undisturbed soil.

F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.

G. Place haunching material manually around the pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside the pipe with sand bags or other suitable means.

H. Place electrical conduit directly on foundation without bedding.

I. Shovel pipe embedment material in place and compact it using pneumatic tampers in restricted spaces, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted spaces. Compact each lift before proceeding with placement of the next lift.

1. Class I embedment materials.

   a. Maximum 6-inches compacted lift thickness.
   b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed the pipe to meet the deflection test criteria.
   c. Moisture content as determined by Contractor for effective compaction without softening the soil of trench bottom, foundation or trench walls.

2. Class II embedment and cement stabilized sand.

   a. Maximum 6-inches compacted thickness.
   b. Compaction by methods determined by Contractor to achieve a minimum of 95 percent of the maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.
   c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on the dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.

J. Place trench dams in Class I embedments in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.05 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only the minimum length of trench open as necessary for construction. Backfill placement and compaction shall apply to all soils excavated for the trench especially including any areas that were “benched” or over-excavated in place of trenched shoring. All disturbed soils generated during excavation, whether inside the trench or associated with it, shall be considered to fall under this requirement.

B. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave the sheeting in place. Cut off sheeting 1.5 feet or more above the crown of the pipe. Remove trench supports within 5 feet from the ground surface.

C. For sewer pipes, use backfill materials described here as determined by trench limits. As trench zone backfill in paved areas for streets and to one foot back of curbs and pavements, use cement stabilized sand for pipe of nominal sizes less than 36 inches, or Bank Sand for pipe of nominal sizes 36 inches and larger as indicated on the Drawings. Uniformly backfill trenches unless specified otherwise according to the paved area criteria. Use select backfill within one foot below pavement subgrade for rigid pavement. For asphalt concrete, use flexible base material within one foot below pavement subgrade.

D. For water lines, backfill in trench zone, including auger pits, with Bank Sand, Select Fill, or Random Fill material as specified in this Section.

E. For trench excavations under pavement, place trench zone backfill in lifts and compact by methods indicated below. Fully compact each lift before placement of the next lift.

1. Bank Sand.

    a. Maximum 9-inches compacted lift thickness.
    b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
    c. Moisture content within 3 percent of optimum determined according to ASTM D 698

2. Cement Stabilized Sand.

    a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but not exceeding 24 inches.
    b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 558.
    c. Moisture content on the dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.

3. Select Fill.

    a. Maximum 6-inches compacted thickness.
    b. Compaction by equipment providing tamping or kneading impact to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
    c. Moisture content within 2 percent of optimum determined according to ASTM D 698.

F. For trench excavations outside pavements, a Random Fill of suitable material may be used in the trench zone.

1. Fat clays (CH) may be used as trench zone backfill outside paved areas at the Contractor's option. If the required density is not achieved, the Contractor, at his option and at no additional cost to the Owner, may use lime stabilization to achieve compaction requirements or use a different suitable material.

2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.

3. Compact to a minimum of 90 percent of the maximum dry density determined according to ASTM D 698, or to same density as adjacent soils.

4. Moisture content as necessary to achieve density.

3.06 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

A. Meet the requirements of adjoining utility installations for backfill of pipeline structures, as shown on the Plans.

3.07 FIELD QUALITY CONTROL

A. Quality Control

1. The Engineer may sample and test backfill at:

   a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.
   b. On-site stockpiles.
   c. Materials placed in the Work.

2. The Engineer may resample material at any stage of work or location if changes in characteristics are apparent.

B. Production Verification Testing: The Owner's testing laboratory will provide verification testing on backfill materials, as directed by the Engineer. Samples may be taken at the source or at the production plant, as applicable.

C. Provide excavation and Trench Safety Systems at locations and to depths required for testing and retesting during construction.

D. Tests will be performed on a minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.

E. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement stabilized sand in accordance with ASTM D 558. Additional moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.

F. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at the following frequencies and conditions.

1. A minimum of one test for every 100 linear feet measured along pipe for compacted embedment and for every 100 linear feet measured along pipe for compacted trench zone backfill material. Testing shall be performed for each lift thickness for different backfill material specified in Item 3.05.

2. A minimum of three density tests for each full shift of Work when backfill is placed.

3. Density tests will be distributed among the placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.

4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.

5. Density tests may be performed at various depths below the fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.

6. Two verification tests will be performed adjacent to in-place tests showing density less than the acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.

7. Re-compacted placement will be retested at the same frequency as the first test series, including verification tests.

G. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For Cement Stabilized Sand with nonconforming density, core and test for compressive strength at Contractor's expense.

H. Acceptability of crushed rock compaction will be determined by inspection.

3.08 CLEAN-UP AND RESTORATION

A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

3.09 PROTECTION OF THE WORK

A. Maintain excavation and embankment areas until start of subsequent work. Repair and re-compact slides, washouts, settlements, or areas with loss of density at no cost to the Owner

B. Prevent erosion at all times. Do not allow water to pond in excavations.

C. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

D. Coordinate excavation within 15 feet of existing utilities with utility representative. Excavate by hand to locate existing utility, support utility with methods agreed upon by utility representative. All work shall be subsidiary to bid items in Section 00300 Bid Proposal. No additional cost to City.

END OF SECTION

Section 02330

EMBANKMENT

1.0 GENERAL

1.01 SECTION INCLUDES

A Construction of embankments with excess excavated material and borrow.

B References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01760 – Project Record Documents
4. Section 01570 – Trench Safety System
5. Section 01450 – Testing Laboratory Services
6. Section 01500 – Temporary Facilities and Controls
7. Section 02255 – Bedding, Backfill and Embankment Material
8. Section 02910 – Topsoil
9. Section 01564 – Control of Ground Water and Surface Water
10. Section 01720 – Field Surveying
11. Section 02220 – Site Demolition
12. Section 02200 – Site Preparation
13. Section 01140 – Contractor's Use of Premises

C Referenced Standards:

1. American Society for Testing and Materials (ASTM)

    a. ASTM D 698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort"
    b. ASTM D 1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method"
    c. ASTM D 2922, "Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"
    d. ASTM D 3017, "Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)"

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for Embankment under this Section. Include cost in Bid Items for which this Work is a component.

B If embankment is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit product quality, material sources, and field quality information in accordance with this Section.

C Submit field red lines documenting location of embankments as installed, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

D Submit a Trench Safety Plan under the provisions of Section 01570 – Trench Safety System that included measures that establish compliance with the standard interpretation of the General Duty Clause, Section 5.(a)(1), of the Occupational Safety and Health Act of 1970 – 20 USC 654 which states, "Employers must shore or otherwise protect employees who walk/work at the base of an embankment from possible collapse."

1.04 TESTING

A Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 MATERIALS

A Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.

B Topsoil: Conform to requirements of Section 02910 – Topsoil.

C Borrow Material: Conform to requirements of intended use. Take borrow material from sources approved by Engineer.

3.0 EXECUTION

3.01 EXAMINATION

A Verify borrow and excess excavated materials to be reused, are approved.

B Verify removals, and clearing and grubbing operations, have been completed.

C Verify backfill of new or relocated utilities and structures, below future grade, is complete.

3.02 PREPARATION

A Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety Systems.

B Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.

C Identify required lines, levels, and datum. Coordinate with Section 01720 – Field Surveying.

D Remove existing pavements and structures, including sidewalks and driveways, in conformance with requirements of Section 02220 – Site Demolition, as applicable.

E Area shall be cleared and grubbed under the provisions of Section 02200 – Site Preparation prior to placing embankment or opening borrow source.

F Strip and stockpile topsoil under the provisions of Section 02200 – Site Preparation.

G Backfill test pits, or stump holes and other surface irregularities such as small swales with embankment materials and compact in proper lift depths according to the compaction requirements of this Section.

H Areas of unsuitable material shall be removed, backfilled with embankment materials and compacted in proper lift depths according to the compaction requirements of this Section.

I Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

3.03 PLACEMENT AND COMPACTION

A Do not conduct placement operations during inclement weather or when existing ground or embankment materials exceed 3 percent of optimum moisture content. Contractor may manipulate wet material to facilitate drying, by disking or windrowing, at Contractor's expense.

B Do not place embankment material until density and moisture content of previously placed material complies with specified requirements.

C Scarify areas to receive embankment to a minimum depth of 4 inches to bond existing and new materials. Mix with first layer of embankment material.

D Spread embankment material evenly, from dumped piles or windrows, into horizontal layers approximately parallel to finished grade. Place to meet specified compacted thickness. Break clods and lumps and mix materials by blading, harrowing, discing, or other approved method. Each layer shall extend across full width of embankment.

E Each layer shall be homogeneous and contain uniform moisture content before compaction. Mix dissimilar abutting materials to prevent abrupt changes in composition of embankment.

F Layers shall not exceed depth as indicated on the Plans.

G Where shown on Plans for steep slopes, cut benches into slope and scarify before placing embankment. Place increasingly wide horizontal layers of specified depth, to the level of each bench.

H Build embankment layers on back slopes, adjacent to existing roadbeds, to level of old roadbed. Scarify top of old roadbed to minimum depth of four inches and re-compact with next layer.

I Construct to lines and grades shown on Plans.

3.04 COMPACTION REQUIREMENTS

A Maintain moisture content of embankment materials to attain required compaction density.

B Compact to minimum densities shown on the Plans with a moisture content of optimum to 3 percent above optimum as determined by ASTM D 698.

3.05 TOLERANCES

A Top of compacted surface: Plus or minus $^1/_2$ inch in cross section, or in 16 foot length.

3.06 FIELD QUALITY CONTROL

A Compaction testing will be performed in accordance with ASTM D 1556 or ASTM D 2922 and ASTM D 3017 under provisions of Section 01450 – Testing Laboratory Services.

B A minimum of three tests will be taken for each 1,000 linear feet per lane of roadway or 500 square yards of embankment per lift.

C If tests indicate work does not meet specified compaction requirements, recondition, re-compact, and retest at Contractor's expense.

3.07 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

B In unpaved areas, grade surface as a uniform slope from installed appurtenances to natural grade and stabilize as indicated on Plans.

3.08 PROTECTION OF THE WORK

A Maintain all embankment areas in good condition until completion of Work.

B Repair and re-compact slides, washouts, settlements, areas with loss of density, or excavation damaged by Contractor's operations at no additional cost to Owner.

C Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

END OF SECTION

Section 02335

SUBGRADE

1.0 GENERAL

1.01 SECTION INCLUDES

A. Foundation course of lime and Portland Cement stabilized in situ subgrade material.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 01500 – Temporary Facilities and Controls
5. Section 01564 – Control of Ground Water and Surface Water
6. Section 01720 – Field Surveying
7. Section 01140 – Contractor's Use of Premises

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM D 4318, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
b. ASTM D 698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort"
c. ASTM D 1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method"
d. ASTM D 2922, "Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"
e. ASTM D 3017, "Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)"
f. ASTM C 150 - Standard Specification for Portland Cement.
g. ASTM D 558 - Standard Test Method for Moisture-Density Relations of Soil-Cement-Mixtures.

1.02 MEASUREMENT AND PAYMENT

A. Measurement for subgrade is on a square yard basis. Separate payment will be made for each different required type and thickness of stabilized Subgrade. Limits of measurement shall match actual pavement replaced, but no greater than maximum pavement replacement limits shown on Drawings. Limits for measurement will be extended to include installed stabilized subgrade material that extends 2 foot beyond outside edge of pavement to be replaced, except where proposed pavement section

shares common longitudinal or transverse edge with existing pavement section. No payment will be made for stabilized subgrade in areas beyond these limits.

B. Measurement for hydrated lime and quicklime is by the ton of 2,000 pounds dry-weight basis, determined by the area to be covered and the rate of application. Do not include cost of hydrated lime or quicklime in Bid Item for subgrade.

C. Measurement for lime slurry is by the ton of 2,000 pounds of lime calculated on the percentage by weight of dry solids for the grade of slurry. Do not include cost of lime slurry in Bid Item for subgrade.

D. Measurement for Portland Cement is by the ton of 2,000 pounds of dry weight basis. Do not include cost of Portland Cement in Bid Item for subgrade.

E. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit certificates stating that hydrated lime, commercial lime slurry and quicklime complies with the requirements in this Section.

C. Submit weight tickets, certified by supplier, with each bulk delivery of lime to Project Site.

D. Submit manufacturer's description and characteristics for rotary speed mixer and compaction equipment for approval.

1.04 TESTING AND SAMPLING

A. Testing will be performed under provisions of Section 01450 – Testing Laboratory Services.

B. Tests and analysis of soil materials will be performed in accordance with ASTM D 4318.

C. Sampling and testing of lime slurry shall be in accordance with Tex-600-J.

D. Sample mixtures of Portland Cement, hydrated lime or quicklime in slurry form will be tested to establish compliance with the requirements in this Section.

E. Soil will be evaluated to establish percent of hydrated lime, quicklime, or lime slurry to be applied to subgrade material.

F. Moisture-density relationship will be established on material sample from roadway, after stabilization, in accordance with ASTM D 698.

G. Soil will be evaluated to establish ratio of cement to soil to obtain desired stability. Normal range is 6 percent to 10 percent by weight.

H. The percentage of moisture in soil, at time of cement application, will be determined by ASTM D 558. Moisture will not be allowed to exceed quantity that will permit uniform, complete mixture of soil and cement during dry mixing operations nor specified optimum moisture content for soil cement mixture, as determined.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A. Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Bagged lime shall bear manufacturer's name, product identification, and certified weight. Bags varying more than 5 percent of certified weight may be rejected; average weight of 50 random bags in each shipment shall not be less than certified weight.

B. Store lime in weatherproof enclosures. Protect lime from ground dampness.

C. Quicklime can be dangerous; exercise extreme caution if used for the Work. Contractor shall become informed about recommended precautions in the handling, storage and use of quicklime.

2.0 PRODUCTS

2.01 WATER

A. Water shall be clean; clear; and free from oil, acids, alkali, or organic matter.

2.02 LIME

A. Type A - Hydrated Lime: Dry material consisting essentially of calcium hydroxide or mixture of calcium hydroxide and an allowable percentage of calcium oxide and magnesium hydroxide.

B. Type B - Lime Slurry: Liquid mixture consisting essentially of lime solids and water in slurry form. Water or liquid portion shall not contain dissolved material in sufficient quantity to be injurious or objectionable for purpose intended.

C. Type C - Quicklime: Dry material consisting essentially of calcium oxide. Furnish quicklime in either of the following grades:

1. Grade DS: Pebble quicklime of a gradation suitable for use in the preparation of a slurry for wet placing.

2. Grade S: Finely-graded quicklime for use in the preparation of a slurry for wet placing. Do not use Grade S quicklime for dry placing. (So called "Blue Lime" is not acceptable.)

D. Lime shall conform to following requirements:

CHEMICAL COMPOSITION	TYPE		
	A	B	C
Active lime content, % by weight $Ca(OH)_2$ + CaO	90.0 min[1]	87.0 min[2]	-
Unhydrated lime content, % by weight CaO	5.0 max	-	87.0 min
Free water content, % by weight H_2O	5.0 max	-	-
SIZING			
Wet Sieve, as % by weight residue retained:			
No. 6	0.2 max	0.2 max[2]	8.0 max[3]
No. 30	4.0 max	4.0 max[2]	-
Dry sieve, as % by weight residue retained:			
1-inch	-	-	0.0
3/4-inch	-	-	10.0 max

Notes:
[1] Maximum 5.0% by weight CaO shall be allowed in determining total active lime content.
[2] Maximum solids content of slurry.
[3] Total active lime content, as CaO, in material retained on the No. 6 sieve shall not exceed 2.0% by weight of original Type C lime.

E. Lime Slurry may be delivered to the Project Site as Commercial Lime Slurry, or may be prepared at the Project Site using Hydrated Lime or Quicklime. The slurry shall be free of liquids other than water and shall be of a consistency that can be handled and uniformly applied without difficulty.

2.03 PORTLAND CEMENT (ONLY WHEN DIRECTED BY ENGINEER)

A. ASTM C 150 Type I, bulk or sacked.

2.04 SOIL

A. Provide soil consisting of approved material free from vegetation or other objectable matter encountered in existing roadbed.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify backfill of new or relocated utilities and structures below future grade is complete.

B. Verify compacted subgrade is ready to support imposed loads.

C. Verify subgrade lines and grades are correct.

3.02 PREPARATION

A. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.

B. Identify required lines, levels, and datum. Coordinate with Section 01720 – Field Surveying.

C. Cut material to bottom of subgrade using an approved cutting and pulverizing machine meeting following requirements:

1. Cutters accurately provide a smooth surface over entire width of cut to plane of secondary grade.
2. Visible indication that cut is to proper depth.

D. Alternatively, scarify or excavate to bottom of stabilized subgrade. Remove material or windrow to expose secondary grade. Correct wet or unstable material below secondary grade by scarifying, adding lime, and compacting. Obtain uniform stability.

E. Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

3.03 LIME SLURRY APPLICATION

A. Mix hydrated lime or quicklime with water to form a slurry of the solids content specified. Commercial lime slurry shall have dry solids content as specified. Conform to cautionary requirements in this Section, 1.06C, concerning use of quicklime.

B. Apply slurry with a distributor truck equipped with an agitator to keep lime and water in a consistent mixture. Make successive passes over measured section of roadway to attain proper moisture and lime content. Limit spreading to an area where preliminary mixing operations can be completed on the same working day.

3.04 PRELIMINARY MIXING

A. Do not mix and place material when temperature is below 40 degrees F and falling. Base may be placed when temperature taken in shade and away from artificial heat is above 35 degrees F and rising.

B. Use approved single-pass or multiple-pass rotary speed mixers to mix soil, lime, and water to required depth. Obtain a homogeneous friable mixture free of clods and lumps.

C. Shape mixed subgrade to final lines and grades.

D. Seal subgrade as a precaution against heavy rainfall by rolling lightly with light pneumatic rollers.

E. Cure soil-lime material for 1 to 4 days. Keep subgrade moist during cure.

3.05 FINAL MIXING

A. Use approved single-pass or multiple-pass rotary speed mixers to uniformly mix cured soil and lime to required depth.

B. Add water to bring moisture content of soil mixture to a minimum of optimum or above.

C. Mix and pulverize until all material passes a 1 inch sieve; a minimum of 90 percent, excluding non-slaking fractions, passes a 3/4-inch sieve; and a minimum of 65 percent excluding non-slaking fractions passes a No. 4 sieve.

D. Shape mixed subgrade to final lines and grades.

E. Do not expose hydrated lime to open air for more than 6 hours during interval between application and mixing. Avoid excessive hydrated lime loss due to washing or blowing.

3.06 MIXING - PORTLAND CEMENT (ONLY WHEN DIRECTED BY ENGINEER)

A. Do not place and mix cement when temperature is below 40 degrees F and falling. Place Portland Cement base when temperature taken in shade and away from artificial heat is above 35 degrees F and rising.

B. Spread cement uniformly on soil at rate specified by laboratory. When bulk cement spreader is used, position it by string lines or other approved method to ensure uniform distribution of cement. Apply cement only to area where operations can be continuous and completed in daylight, within 1 hour of application. Amount of moisture in soil at time of cement placement shall not exceed quantity that will permit uniform mixture of soil and cement during dry mixing operations. Do not exceed specified optimum moisture content for soil cement mixture.

C. Do not allow equipment other than that used in spreading and mixing, to pass over freshly spread cement until it is mixed with soil.

D. Dry mix cement with soil after cement application. Continue mixing until cement has been sufficiently blended with soil to prevent formation of cement balls when water is applied. Mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than 30 minutes.

E. Immediately after dry mixing is complete, uniformly apply water as necessary and incorporate it into mixture. Pressurized equipment must provide adequate supply to ensure continuous application of required amount of water to sections being processed within 3 hours of cement application. Ensure proper moisture distribution at all times. After last increment of water has been added, continue mixing until thorough and uniform mix has been obtained.

F. Ensure percentage of moisture in mixture, based on dry weights, is within 2 percentage points of specified optimum moisture content prior to compaction. When uncompacted soil cement mixture is wetted by rain indicating that average moisture content exceeds tolerance given at time of final compaction, reconstruct entire section in accordance with this Section at no additional cost to City.

3.07 COMPACTION - LIME SUBGRADE

A. Aerate or sprinkle to attain optimum moisture content as determined by Testing Laboratory. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.

B. Start compaction immediately after final mixing, unless approved by Engineer.

C. Spread and compact in two or more approximately equal layers where total compacted thickness is to be greater than 8 inches.

D. Compact with approved heavy pneumatic or vibrating rollers, or a combination of tamping rollers and light pneumatic rollers. Begin compaction at the bottom and continue until entire depth is uniformly compacted.

E. Do not allow stabilized base to mix with underlying material. Correct irregularities or weak spots immediately by replacing material and re-compacting.

F. Compact to following minimum densities at a moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on the Plans:

1. Areas to receive pavement without subsequent base course: Minimum density of 98 percent of maximum dry density.

2. Areas to receive subsequent base course: Minimum density of 95 percent of maximum dry density.

G. Seal with approved light pneumatic tired rollers: Prevent surface hair line cracking. Rework and re-compact at areas where hair line cracking develops.

H. Contractor shall conduct operations to minimize elapsed time between mixing and compacting stabilized subgrade in order to take advantage of rapid initial set characteristics. Complete compaction within 2 hours of commencing compaction and not more than 6 hours after adding and mixing the last stabilizing agent.

3.08 COMPACTION - PORTLAND CEMENT SUBGRADE (ONLY WHEN DIRECTED BY ENGINEER)

A. Prior to beginning compaction, ensure mixture is in loose condition for its full depth. Uniformly compact the loose mixture to specified density, lines and grades.

B. After soil and cement mixture is compacted, apply water uniformly as needed and mix thoroughly. Then reshape surface to required lines, grades and cross section and lightly scarify to loosen imprints left by compacting or shaping equipment.

C. Roll resulting surface with pneumatic-tired roller and "skin" surface with power grader. Thoroughly compact mixture with pneumatic roller, adding small increments of moisture, as needed. When aggregate larger than No. 4 sieve is present in mixture, make one complete coverage of section with flat-wheel roller immediately after skinning operation. When approved by Project Manager, surface finishing methods may be varied from this procedure, provided dense uniform surface, free of surface compaction planes, is produced. Maintain moisture content of surface material at its specified optimum during finishing operations. Compact and finish surface within period not to exceed 2 hours, to produce smooth, closely knit surface, free of cracks, ridges, or loose material, conforming to crown, grade and line shown on Drawings within period not to exceed 2 hours.

3.09 CURING

A. Moist cure for a minimum of 3 days before placing base or surface course, or opening to traffic. Time may be adjusted as approved by Engineer. Subgrade may be opened to traffic after 2 days if adequate strength has been attained to prevent damage. Restrict traffic to light pneumatic rollers or vehicles weighing less than 10 tons.

B. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together.

C. Place base, surface, or seal course within 14 days after final mixing and compaction unless prior approval is obtained from Engineer.

3.10 TOLERANCES

A. Top of compacted surface: Plus or minus 1/4 inch in cross section or in 16 foot length.

3.11 FIELD QUALITY CONTROL

A. A minimum of three phenolphthalein test will be made at random locations per 1000 linear feet per lane of roadway or 500 square yards of base to determine in-place depth.

B. Contractor may, at his own expense, request additional cores in the vicinity of cores indicating nonconforming in-place depths. If the average of the tests falls below the required depth, place and compact additional material at no cost to the Owner.

C. Compaction Testing will be performed in accordance with ASTM D 1556 or ASTM D 2922 and ASTM D 3017 at random locations near depth determination tests. Three tests will be performed for each 1000 foot roadway section. Rework and re-compact areas that do not conform to compaction requirements at no cost to the Owner.

3.12 CLEAN-UP AND RESTORATION

A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

B. Fill test pits with new compacted lime stabilized subgrade.

C. Completed surface shall be smooth and conform to typical section and established lines and grades.

D. In unpaved areas, grade surface as a uniform slope from installed appurtenances to natural grade and stabilize as indicated on Plans.

3.13 PROTECTION OF THE WORK

A. Maintain stabilized Subgrade to lines and grades and in good condition until placement of base or surface course.

B. Protect the asphalt membrane, if used, from being picked up by traffic.

C. Repair settlements, areas with loss of density, or areas of subgrade damaged by Contractor's operations at no additional cost to Owner by replacing and re-compacting material to full depth.

D. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

END OF SECTION

Section 02370

GEOTEXTILE

1.0 GENERAL

1.01 SECTION INCLUDES

A Geotextile also called filter fabric, in applications such as under a granular fill, as a pipe embedment wrap, around the exterior of a tunnel liner, or around the foundations of pipeline structures.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles"
   b. ASTM D 4533, "Standard Test Method for Trapezoid Tearing Strength of Geotextiles"
   c. ASTM D 4833, "Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products"
   d. ASTM D 3786, "Standard Test Method for Hydraulic Bursting strength of Textile Fabrics"
   e. ASTM D 4751, "Standard Test Method for Determining Apparent Opening Size of a Geotextile"
   f. ASTM D 4491, "Standard Test Method for Water Permeability of Geotextiles by Permittivity"
2. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for work performed under this Section. Include cost in Bid Items for Work requiring geotextile.

B If Geotextile is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit the standard manufacturer's catalog sheets and other pertinent information, for approval, prior to installation.

C Submit installation methods, as a part of the work plan for tunneling or for excavation and backfill for utilities. Obtain approval from Engineer for Geotextile material and the proposed installation method prior to use of the geotextile.

2.0 PRODUCTS

2.01 GEOTEXTILE

A Provide a geotextile (filter fabric) designed for use in geotechnical applications which forms a permeable layer or media while retaining the soil matrix.

B Use a fabric which meets the physical requirements for Class A Subsurface Drainage installation conditions as defined in AASHTO M288 and as specified in this Section, **2.02** "Properties".

2.02 PROPERTIES

A Material: Non-woven, non-biodegradable, fabric consisting only of continuous chain polymer filaments or yarns, at least 85 percent by weight poly-olefins, polyesters or polyamide, formed into a dimensionally stable network.

B Chemical Resistance: Inert to commonly encountered chemicals and hydrocarbons over a pH range of 3 to 12.

C Physical Resistance: Resistant to mildew and rot, ultraviolet light exposure, insects and rodents.

D Minimum Test Values:

PROPERTY	VALUE (MIN)	TEST METHOD
Grab strength	180 lbs	ASTM D 4632
Trapezoidal Tear Strength	50 lbs	ASTM D 4533
Puncture Strength	80 lbs	ASTM D 4833
Mullen Burst Strength	290 psi	ASTM D 3786
Apparent Opening Size (1)	0.25 mm	ASTM D 4751
Permittivity (sec^{-1})	0.2	ASTM D 4491

(1) Maximum average roll value

3.0 EXECUTION - Not used

END OF SECTION

Section 02415

AUGERING PIPE OR CASING FOR SEWERS

1.0 GENERAL

1.01 SECTION INCLUDES

A Installation of pipe and casing for sanitary sewer by methods of augering.

B References to Technical Specifications:
1. Section 01570 – Trench Safety System
2. Section 01200 – Measurement and Payment Procedures
3. Section 01350 – Submittals
4. Section 01563 – Control of Ground Water and Surface Water
5. Section 01500 – Temporary Facilities and Controls
6. Section 02530 – Gravity Sanitary Sewers
7. Section 02430 – Tunnel Grout
8. Section 02318 – Excavation and Backfill for Utilities
9. Section 01140 – Contractor's Use of Premises

C Referenced Standards:
1. American Railway Engineering Association (AREA) Manual for Railway Engineering
2. American Association of State Highway and Transportation Officials (AASHTO)
3. American Water Works Association (AWWA)
   a. AWWA C200, Steel Water Pipe - 6 in. (150 mm) and Larger

D Definitions:
1. Dry Augering - installation of steel casing by excavating the soil at the advancing end of casing and transporting the spoil through the casing by an otherwise uncased auger, while advancing the casing by jacking at the same rate as the auger excavation progresses.
2. Slurry Augering - installation of casing or sewer pipe by first drilling a small diameter pilot hole from auger pit to auger pit, followed by reaming the bore to full diameter by augering with slurry, and installing the casing or pipe by a pull-back or jacking method.
3. Augered Pipe - the Contractor's installed water or sewer pipe in augered hole.
4. Augered Casing with Pipe - the Contractor's installed water or sewer pipe in augered casing.

1.02 MEASUREMENT AND PAYMENT

A Measurement for augered casing with sewer pipe will be on a linear foot basis measured from end to end of the casing.

B Payment of augered casing with sewer pipe will be full compensation for all labor, equipment, casing, sewer pipe, materials and supervision for construction complete in place including dewatering, augering, joints, spoil removal, pipe installation, grouting, utility adjustments, testing, and cleanup, and other work necessary for construction as shown on the Plans and as specified.

C Measurement of augered sewer pipe will be on a linear foot basis along the axis of the pipe from auger pit to auger pit.

D Payment of augered sewer pipe will be full compensation for labor, pipe, equipment, materials, and supervision for construction complete in place including dewatering, jacking, utility adjustments, testing, cleanup, and other work necessary for construction as shown on the Plans and as specified.

E No separate payment will be made for auger pits and other excavations under this section. Include cost of excavation, surface restoration, pavement repair, etc., for auger pits or observation pits in Sections related to the open-cut sewer installation portion of the Work. Include cost of trench safety for auger pits or observation pits in Section 01570 – Trench Safety Systems.

F Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Review. Submittal shall be made in accordance with Section 01350 – Submittals. The Engineer will review submitted plans, details and data for compliance with specifications. Contractor shall not commence work on any items requiring pipe and casing augering work plan, or other submittal until the submittal have been reviewed and accepted by the Engineer. Such review by the Engineer shall not be construed in any way of relieving the Contractor of his responsibilities under the Contract, shall not be construed by the contractor as an endorsement by the Engineer that such methods are constructable or will work for the specific subsurface soils encountered. Structural designs and other engineered components shall be signed and sealed by a Professional Engineer registered in the State of Texas.

B Pipe and Casing Augering Operation.

1. Submit for review a Pipe and Casing Augering Work Plan with complete drawings and written description identifying details of the proposed method of construction and the sequence of operations to be performed during construction, as required. The drawings and descriptions shall be sufficiently detailed to demonstrate to the Engineer whether the proposed materials and procedures will meet the requirements of this Section.
2. Depending on the Contractor's method of construction, the Pipe and Casing Augering Work Plan shall be submitted on the following items:
    a. Arrangement drawings and technical specifications of the augering equipment and experience record of the Contractor.
    b. Method of controlling line and grade of augering operation.

c. Method of spoil and slurry removal, including surface storage and disposal.
d. Details of the pipe or casing installation.
e. Grouting techniques to be used for filling annular void between casing and sewer pipe, where required, and for filling over excavation, if any, including equipment, pumping and injection procedures, pressure grout types, and mixtures.
f. Location and construction of auger pits, including details for all required ground support installation not included in the Trench Safety Plan.
g. Groundwater control system per requirements in this section and in accordance with Section 01563 – Control of Ground Water and Surface Water, as required by construction method.

3. Casing and pipe fabrication drawings, including joint details.

C Trench Safety

1. Shall be in accordance with Section 01570 – Trench Safety System.
2. To the extent that excavation for pipe and casing augering involves work not covered by Contractor's Trench Safety Plan, the safety provisions of these excavations shall be addressed in the Pipe and Casing Augering Work Plan.

D Quality Control Methods. At least 30 days prior to the start of augering, the Contractor shall submit a description of the quality control methods proposed for use in this operation to the Project Manager. The submittal shall include:

1. Supervision. Supervisory control to ensure that work is performed in accordance with the Plans and Specifications, and Pipe and Casing Augering Work Plan.
2. Line & Grade. Procedures for surveying, controlling and checking line and grade, including field forms.
3. Augering Observation and Monitoring. Procedures for preparing and submitting daily logs of augering operations, including field forms.
4. Products and Materials. A plan for testing and submittal of test results to demonstrate compliance with the specification and Contractor's design criteria for permanent products, material and installations. The plan shall identify applicable standards and procedures for testing and acceptance.
5. Monitoring Settlement. Submit a settlement Monitoring Plan if requested by the Engineer.

1.04 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

1.05 CRITERIA FOR DETERMINING INSTALLATION LOADS

A Pipes and casings shall be selected by the Contractor to carry overburden pressure and applicable surcharge and installation loads.

B The criteria to be used for truck loading shall be HS-20 vehicle loading distributions in accordance with AASHTO.

C The Contractor shall be responsible for the selection of the casing, pipe, and pipe joints to carry the thrust of the jacks or loads due to the pulling mechanism.

D The Contractor shall select the diameter of the casing to meet the minimum dimensions defined in the Plans, and to permit practical installation (including skids, pipe spiders and shims, if applicable) and grouting, where required.

2.0 PRODUCTS

2.01 MATERIALS

A Casing shall be provided where shown on Plans or indicated in Technical Specifications and be new, uncoated welded steel pipe, manufactured in accordance with AWWA C200. The design stress in the pipe wall shall be 50 percent of the minimum yield point of the steel or 18,000 psi, whichever is less, when subjected to the loading conditions. The design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.

B Sewer pipe shall be provided in accordance with Section 02530 – Gravity Sanitary Sewers. The sewer pipe shall be selected by the Contractor and verified by the Contractor's engineer to safely withstand all service loads, including overburden pressures and surcharge loads together with all forces and pressures induced in pipe and joints during installation.

C For grouting materials refer to Section 02430 – Tunnel Grout.

D Where casings are required by Plans, casing insulator width 8 inches for pipe sizes 4 to 14 inches; 12 inches for pipe sizes 16 to 30 inches.

1. For welded steel pipe 12 inches and smaller, use Pipeline Seal & Insulator Model PE, or approved equal.
2. For other pipe materials, use Pipeline Seal & Insulator Model C8G-2 or approved equal for pipe sizes up to 12 inches.
3. For all pipe sizes above 12 inches, use Pipeline Seal & Insulator Model C12G-2 or approved equal.

E Casing End Seals: Provide Pipeline Seal & Insulator Model C or approved equal.

3.0 EXECUTION

3.01 DRY AUGERING (CASING ONLY)

A Provide horizontal augering equipment of sufficient capacity for the diameter and length of the casing to be installed and the anticipated ground conditions.

B Provide heavy-duty jacks of a capacity suitable for forcing the excavating auger and casing through the ground and a suitable jacking frame or backstop. Use operating jacks constructed so that even pressure is applied to all jacks used.

C Provide steerable front section of casing to allow vertical grade adjustments. A water level or other means shall be provided to allow monitoring of the grade elevation of the auger casing.

D Set casing to be jacked on guides, properly braced together, to support the section of pipe and direct it to proper line and grade. Place the whole jacking assembly so as to line up with the direction and grade of the pipe.

E In unconsolidated soil formations, bentonite may be used to seal the voids outside the wall and furnish lubrication for the installation of casing. The use of water to assist in lubrication to facilitate the removal of spoil is permitted, however, water jetting of the soil is not allowed when jacking the casing.

F Insofar as practical and depending on the character of the soil encountered during the augering operation, conduct operations without interruption to prevent the pipe from seizing up in the hole before the installation is complete.

G Repair casing damaged in augering operations by method acceptable to the Engineer or remove and replace it.

3.02 SLURRY AUGERING

A Provide horizontal boring equipment for drilling of pilot hole, slurry augering equipment for excavating the full-sized hole for casing or pipe installation.

B Drill a small diameter pilot hole for the entire length of the augered pipe. Check the pilot hole for line and grade at the receiving end to determine if the larger diameter casing hole will comply with this Specification. The pilot hole shall be redrilled if the installed pipe would not meet the specified tolerances.

C Auger the large-diameter hole by mechanical means for reaming the pilot hole. The diameter of the augered hole shall be not more than 1 inch greater than the outside diameter of the installed pipe measured from the barrel of the pipe. Place excavated material outside the working pit and dispose of it, as specified in Section 01500 – Temporary Facilities and Controls. Jetting is not permitted. Augered holes which do not meet the specified tolerances shall be grouted.

D In unconsolidated soil formations, use a bentonite slurry to maintain a stable hole and furnish lubrication for the installation of the pipe. Install the pipe or casing in one

operation with the displacement of cuttings and slurry from the hole in potentially unstable soils to prevent casing and settlement of the ground surface.

E Depending on the character of the soil encountered during the augering operation, conduct operations without interruption, insofar as practical, to prevent the pipe from seizing up in the hole before the installation is complete.

F Repair casing or sewer pipe damaged in augering operations by method acceptable to the Engineer or remove and replace it.

3.03 AUGER PITS

A Contractor's Pipe and Casing Augering Work Plan shall identify the location, size, depth and layout, and ground support design of all augering and observation pits, as well as a schedule of dates that each pit is expected to be open.

B Auger pits that are excavated as a part of open-cut sewer construction shall be in accordance with Section 02318 – Excavation and Backfill for Utilities.

C Install sheeting, lining, shoring, and bracing required for the protection of the workmen and the public in accordance with Section 01570 – Trench Safety Systems.

3.04 PIPE IN CASING

A Pipes shall be installed in augered casings in accordance with this Section, as applicable.

B Bottom of trench adjacent to each end of casing should be graded to provide firm, uniform, and continuous support for carrier pipe. If trench requires some backfill to establish final trench bottom grade, backfill material should be placed in 6-inch lifts and each layer properly compacted.

C Install casing end seals in accordance with manufactures specifications.

3.05 SPACER AND INSULATOR INSTALLATION

A Casing spacers and/or insulators should be installed in accordance with manufacturer's instructions. Special care should be taken to ensure that all subcomponents are correctly assembled and evenly tightened, and that no damage occurs during tightening or carrier pipe insertion.

B Spacing of spacers or insulators should ensure that carrier pipe is adequately supported throughout its length, particularly at ends, to offset settling and possible electrical shorting. End spacer must be within 6 inches of end of casing pipe, regardless of size of casing and carrier pipe or type of spacer used. Casing spacers are designed to withstand much greater loads than can be safely applied to most coatings. Therefore, spacing between spacers depends largely on load bearing capabilities of pipe coating and flexibility of pipe.

1. Spacing shall be as shown on Plans with maximum distance between spacers to be 10 feet for pipe sizes 4 to 14 inches and 8 feet for pipe sizes 16 to 30 inches.
2. For ductile iron pipe, flanged pipe, or bell-and-spigot pipe, spacers should be installed within one foot on each side of bell or flange and one in center of joint when 18- to 20-foot-long joints are used.
3. If casing or carrier pipe is angled, bent, or dented, spacing should be reduced.

C Where metallic carrier pipe is to be placed in metallic casing, provide electric insulating type spacers to ensure no contact between carrier pipe and casing.

3.06 TOLERANCES

A Acceptance criteria for Augered Casing, as defined in this Section, 1.01D, shall be ±6 inches in horizontal alignment from theoretical at any point between manholes, including the receiving end, and ±1-1/2 inches in elevation from the theoretical.

B Acceptance criteria for Augered Pipe, as defined in this Section, 1.01D, shall be ±6 inches in horizontal alignment from theoretical at any point between manholes, including the receiving end, and ±1/8 inch in elevation from the theoretical.

C If a deviation exceeds these tolerances, the Contractor may be required to re-auger the casing or sewer pipe at no additional cost to the City, including any backfilling or grouting of the abandoned hole. Any redesign of the sewer and manholes made necessary by out-of-tolerance casing or sewer pipe shall be at the Contractor's expense and shall be signed by a Professional Engineer registered in the State of Texas. The installed pipe must be capable of meeting the design flow and velocities for a full pipe condition. Contractor is responsible for final selection of casing diameter to assure these tolerances.

3.07 FIELD QUALITY CONTROL

A Sewer pipes installed under this Section shall be tested under the provisions of the applicable Technical Specification for the type of sewer pipe installed.

3.08 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

3.09 PROTECTION OF THE WORK

A Protect and maintain all pipe and casing augering in good condition until completion of Work.

END OF SECTION

Section 02417

AUGERING PIPE OR CASING FOR WATER LINES

1.0 GENERAL

1.01 SECTION INCLUDES

A Installation of pipe and casing for water lines by methods of augering.

B References to Technical Specifications:
1. Section 01570 – Trench Safety System
2. Section 01200 – Measurement and Payment Procedures
3. Section 01350 – Submittals
4. Section 01500 – Temporary Facilities and Controls
5. Section 02635 – Steel Pipe and Fittings
6. Section 02318 – Excavation and Backfill for Utilities
7. Section 01140 – Contractor's Use of Premises

C Referenced Standards:
1. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT UNIT PRICES

A Measurement for augered casing with water pipe will be on a linear foot basis measured from end to end of the casing.

B Payment of augered casing with water pipe will be full compensation for all labor, equipment, casing, water pipe, materials and supervision for construction complete in place including dewatering, augering, joints, spoil removal, pipe installation, grouting, utility adjustments, testing, and cleanup, and other work necessary for construction as shown on the Plans and as specified.

C Measurement of augered water pipe will be on a linear foot basis along the axis of the pipe from auger pit to auger pit.

D Payment of augered water pipe will be full compensation for labor, pipe, equipment, materials, and supervision for construction complete in place including dewatering, jacking, utility adjustments, testing, cleanup, and other work necessary for construction as shown on the Plans and as specified.

E No separate payment will be made for auger pits and other excavations under this section. Include cost of excavation, surface restoration, pavement repair, etc., for auger pits or observation pits in Sections related to the open-cut utility installation portion of the Work. Include cost of trench safety for auger pits or observation pits in Section 01570 – Trench Safety Systems.

F Refer to Section 01200 - Measurement and Payment Procedures.

1.03 SUBMITTALS

A Submit product data in accordance with requirements of Section 01350 - Submittals.

B Submit product data for casing insulators for approval.

C Prior to commencement of work, furnish for the Engineer's approval, a plan showing pit locations. Approval of this plan will not relieve Contractor from responsibility to obtain specified results.

D Show actual pit locations dimensioned on as-built drawings so that they can be identified in field.

1.04 REGULATORY REQUIREMENTS

A Conform to Texas Department of Transportation for installations under state highways. Owner will obtain required permits for State Highway crossings. City will make submittal to TxDOT. Contractor will supply Traffic Control Plans.

B Installations under railroads:

1. Secure and comply with requirements of right-of-entry for crossing railroad company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements. Submit copy to the Engineer.
2. Use dry auger method only.
3. No extra compensation for damages due to delays caused by the railroad requesting work to be done at hours which will not inconvenience the railroad.
4. Maintain minimum 35-foot clearance from centerline of tracks.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

1.06 CRITERIA FOR DETERMINING INSTALLATION LOADS

A Pipes and casings shall be selected by the Contractor to carry overburden pressure and applicable surcharge and installation loads.

B The criteria to be used for truck loading shall be HS-20 vehicle loading distributions in accordance with AASHTO.

C The Contractor shall be responsible for the selection of the casing, pipe, and pipe joints to carry the thrust of the jacks or loads due to the pulling mechanism.

D The Contractor shall select the diameter of the casing to meet the minimum dimensions defined in the Plans, and to permit practical installation (including skids, pipe spiders and shims, if applicable) and grouting, where required.

2.0 PRODUCTS

2.01 MATERIALS

A Piping and Fittings: As required by Plans.

B Casings: Where required by Plans, in accordance with Section 02635 - Steel Pipe and Fittings.

C Insulators: Where casings are required by Plans, casing insulator width 8 inches for pipe sizes 4 to 14 inches; 12 inches for pipe sizes 16 to 30 inches.

1. For welded steel pipe 12 inches and smaller, use Pipeline Seal & Insulator Model PE, or approved equal.
2. For other pipe materials, use Pipeline Seal & Insulator Model C8G-2 or approved equal for pipe sizes up to 12 inches.
3. For all pipe sizes above 12 inches, use Pipeline Seal & Insulator Model C12G-2 or approved equal.

D Casing End Seals: Provide Pipeline Seal & Insulator Model C or approved equal.

3.0 EXECUTION

3.01 GENERAL

A Do not exceed 100 feet for length of auger hole for uncased PVC pipe less than 12 inches in diameter without intermediate pit.

B Do not exceed 75 feet for length of auger hole for uncased PVC pipe 12 inches to 16 inches in diameter without intermediate pit.

C Do not exceed 80 feet for length of auger hole for uncased PVC pipe greater than 16-inches in diameter without intermediate pit.

3.02 PREPARATION

A Secure right-of-entry for crossing railroad company's easement or right-of-way.

3.03 JACKING

A Comply with Section 01570 - Trench Safety Systems for all pits, access shafts, end trenches and other excavations relating to work required by this specification.

B If grade of pipe at jacking end is below ground surface, excavate suitable pits or trenches for conducting jacking operations and for placing end joints of pipe. Wherever end trenches are cut in sides of embankment or beyond it, sheath securely and brace such work to prevent earth caving.

C No more than one joint shall be made-up in pit or trench prior to jacking.

D Construction shall not interfere with operation of railroad, street, highway, or other facility, nor weaken or damage embankment or structure.

E During construction operations, furnish and maintain barricades and lights to safeguard traffic and pedestrians as directed by the Engineer, until such time as backfill has been completed and removed from site.

F Provide heavy-duty jacks suitable for forcing pipe through embankment. Use suitable jacking head, usually of timber, and suitable bracing between jacks and jacking head and suitable jacking frame or backstop so that jacking pressure will be applied to pipe uniformly around ring of pipe. Set pipe to be jacked on guides, properly braced together, to support section of pipe and to direct it in proper line and grade. Place jacking assembly in line with direction and grade of pipe. Excavate embankment material just ahead of pipe and remove material through pipe. Force pipe through embankment with jacks, into space thus provided.

G Conform excavation for underside of pipe to contour and grade of pipe, for at least one third of circumference of pipe. Provide clearance of not more than 2 inches for upper half of pipe. Taper off upper clearance to zero at point where excavation conforms to contour of pipe.

H Distance that excavation shall extend beyond end of pipe depends on character of material, but it shall not exceed 2 feet in any case. Decrease distance on instructions from the Engineer, if character of material being excavated makes it desirable to keep advance excavation closer to end of pipe.

I Jack pipe from low or downstream end. Lateral or vertical variation in final position of pipe from line and grade established by the Engineer will be permitted only to extent of 1 inch in 10 feet, provided such variation is regular and only in one direction and that final grade of flow line is in direction indicated on plans.

J Use cutting edge of steel plate around head end of pipe extending short distance beyond end of pipe with inside angles or lugs to keep cutting edge from slipping back onto pipe.

K Once jacking of pipe is begun, carry on without interruption to prevent pipe from becoming firmly set in embankment.

L Remove and replace any pipe damaged in jacking operations.

M Backfill pits or trenches excavated to facilitate jacking operations immediately after completion of jacking of pipe.

N Grout annular space when loss of embankment occurs or when clearance of two inches is exceeded.

3.04 AUGERING (BORING)

A Auger from approved pit locations. Excavate for pits and install shoring as outlined above under "Jacking." Auger mechanically with use of a pilot hole entire length of crossing and check for line and grade on opposite end of bore from work pit. The large hole is to be no more than 2 inches larger than diameter of bell. Place excavated material outside working pit and dispose of as required. Use water or other fluids in connection with boring operation only to lubricate cuttings; jetting will not be permitted.

B In unconsolidated soil formations, a gel-forming colloidal drilling fluid may be used. Fluid is to consist of at least 10 percent of high-grade processed bentonite and shall consolidate cuttings of bit, seal walls of hole, and shall furnish lubrication for subsequent removal of cuttings and installation of pipe.

3.05 PIPE IN CASING

A Pipes shall be installed in augered casings in accordance with this Section, as applicable.

B Bottom of trench adjacent to each end of casing should be graded to provide firm, uniform, and continuous support for carrier pipe. If trench requires some backfill to establish final trench bottom grade, backfill material should be placed in 6-inch lifts and each layer properly compacted.

C Install casing end seals in accordance with manufactures specifications.

3.06 INSULATOR INSTALLATION

A Casing spacers and/or insulators should be installed in accordance with manufacturer's instructions. Special care should be taken to ensure that all subcomponents are correctly assembled and evenly tightened, and that no damage occurs during tightening or carrier pipe insertion.

B Spacing of spacers or insulators should ensure that carrier pipe is adequately supported throughout its length, particularly at ends, to offset settling and possible electrical shorting. End spacer must be within 6 inches of end of casing pipe, regardless of size of casing and carrier pipe or type of spacer used. Casing spacers are designed to withstand much greater loads than can be safely applied to most coatings. Therefore, spacing between spacers depends largely on load bearing capabilities of pipe coating and flexibility of pipe.

1. Spacing shall be as shown on Plans with maximum distance between spacers to be 10 feet for pipe sizes 4 to 14 inches and 8 feet for pipe sizes 16 to 30 inches.
2. For ductile iron pipe, flanged pipe, or bell-and-spigot pipe, spacers should be installed within one foot on each side of bell or flange and one in center of joint when 18- to 20-foot-long joints are used.
3. If casing or carrier pipe is angled, bent, or dented, spacing should be reduced.

C Where metallic carrier pipe is to be placed in metallic casing, provide electric insulating type spacers to ensure no contact between carrier pipe and casing.

3.07 FILLING ANNULAR SPACE

A Allowable variation from line and grade shall be as specified under "Jacking." Block void space around pipe in augered hole with approximately 12 inches of packed clay or similar material approved by the Engineer, to prevent bedding or backfill from entering the void around the pipe in the augered hole when compacted. For pipe diameters 4 inches through 8 inches use minimum 1/2 cubic foot clay for pipe diameters 12 inches through 16 inches use minimum 3/4 cubic foot clay.

3.08 AUGER PITS

A Locate auger pits where there is minimum interference with traffic or access to property.

B Pit Size: Provide minimum 6-inch space between pipe and walls of bore pit. Maximum allowable width of pit shall be 5 feet unless approved by the Engineer. Width of pit at surface shall not be less than at bottom. Maximum allowable length of pit shall be no more than 5 feet longer than one full joint of pipe and shall not exceed 25 feet unless approved by the Engineer.

C Excavate bore pits to finished grade at least 6 inches lower than grade indicated by stakes or as approved by the Engineer.

D Backfill in accordance with Section 02318 – Excavation and Backfill for Utilities.

3.09 CLEAN UP AND RESTORATION

A Perform clean up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

3.10 PROTECTION OF THE WORK

A Protect and maintain all pipe and casing augering in good condition until completion of Work.

END OF SECTION

SECTION 02430

TUNNEL GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mix design requirements, testing, furnishing and production of grout for:

1. Pressure grouting of bolted liner plates for shafts.
2. Pressure grouting of primary tunnel liner.
3. Pressure grouting of jacked-pipe.
4. Annular grouting of cased or uncased sewer pipe.
5. Grouting of the annular space between the sanitary sewer pipe and the primary tunnel liner.
6. Grouting voids in ground resulting from caving, loss of ground, or settlement.
7. Grouting of manholes constructed in shafts.

B. Compaction grouting is not part of this specification.

1.02 UNIT PRICE

A. No separate payment will be made for work performed under this Section. Include the cost of such work in contract unit prices for work of which it is a component part.

1.03 DEFINITIONS

A. Pressure Grouting. Filling a void behind a liner or pipe with grout under pressure sufficient to ensure void is properly filled but without overstressing temporary or permanent ground support, or causing ground heave to occur.

B. Back Grouting. Secondary pressure grouting to ensure that voids have been filled between primary tunnel or shaft liners and the surrounding ground.

C. Annular Grouting. Filling the annular space between the carrier pipe and the primary tunnel liner, casing, or ground, by pumping.

D. Ground Stabilization Grouting. The filling of voids, fissures, or under-slab settlement due to caving or loss of ground by injecting grout under gravity or pressure to fill the void.

1.04 SUBMITTALS

A. Make submittals in accordance with all provisions and sections of these specifications.

B. Submit a description of materials, grout mix, equipment and operational procedures to accomplish each grouting operation. The description may include sketches as appropriate, indicating type and location of mixing equipment, pumps, injection points, venting method, flowlines, pressure measurement, volume measurement, grouting sequence, schedule, and stage volumes.

C. Submit a grout mix design report, including:

1. Grout type and designation.

2. Grout mix constituents and proportions, including materials by weight and volume.

3. Grout densities and viscosities, including wet density at point of placement.

4. Initial set time of grout.

5. Bleeding, shrinkage/expansion.

6. Compressive strength.

D. For cellular grout, also submit the following:

1. Foam concentrate supplier's certification of the dilution ratio for the foam concentrate.

2. A description of the proposed cellular grout production procedures.

E. Maintain and submit logs of grouting operations indicating pressure, density, and volume for each grout placement.

PART 2 PRODUCTS

2.01 MATERIALS

A. Grouting materials: Conform to Section 03305 - Concrete for Utility Construction, except as modified in the following paragraphs.

B. Grout Type Applications.

1. Grout for pressure grouting and back grouting: Sand-cement mortar mix.

2. Grout for annular grouting: Low density (cellular) grout or sand-cement mortar mix.

3. Grout for filling space around manholes in shafts: Sand-cement mortar mix.

4. Ground stabilization: Sand cement mortar mix.

5. Do not include toxic or poisonous substances in the grout mix or otherwise inject such substances underground.

2.02 GROUT

A. Employ and pay for a commercial testing laboratory, acceptable to the Owner's Representative, to prepare and test the grout mix design. Develop one or more mixes based on the following criteria as applicable:

1. Size of the annular void between sewer pipe and liner, or size of the void between primary liner and the surrounding soil.

2. Absence or presence of groundwater.

3. Adequate retardation.

4. Non-shrink characteristics.

5. Pumping distances.

B. Prepare mixes that satisfy the required application. Materials used in grout mix shall meet the following standards:

1. Cement: ASTM C150.

2. Fly Ash: ASTM C618.

3. Water: Potable.

4. Foam: ASTM C869.

5. Slurry: ASTM C138.

6. Cellular Grout: ASTM C138.

7. Sand for sand-cement mortar mix: ASTM C144.

C. Provide grout that meets the following minimum requirements:

1. Minimum 28 day unconfined compressive strength: 1,000 psi for sand-cement mortar grout; 300 psi for cellular grout.

2. Determine strength by ASTM C942.

D. Fluidifier. Use a fluidifier, meeting ASTM C937, which holds the solid constituents of the grout in colloidal suspension and is compatible with the cement and water used in the grouting operations.

E. Admixtures.

1. Use admixtures meeting ASTM C494 and ASTM C1017 as required, to improve pumpability, to control time of set, to hold sand in suspension and to reduce segregation and bleeding.

2. For cellular grout, do not use foam or admixtures that promote steel corrosion.

3. Ensure that admixtures used in a mix are compatible. Provide written confirmation from the admixtures' manufacturers of their compatibility.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify the Owner's Representative at least 24 hours in advance of grouting operations.

B. Select and operate grouting equipment to avoid damage to new or existing underground utilities and structures.

C. In selection of grouting placement consider pipe flotation, length of pipe, length of tunnel, depth from surface, type of sewer pipe, type of pipe blocking and bulkheading, grout volume and length of pipe to be grouted between bulkheads.

D. Operate any dewatering systems until the grouting operations are complete.

3.02 EQUIPMENT

A. Batch and mix grout in equipment of sufficient size and capacity to provide the necessary quality and quantity of grout for each placement stage.

B. Use equipment for grouting of a type and size generally used for the work, capable of mixing grout to a homogeneous consistency, and providing means of accurately measuring grout component quantities and accurately measuring pumping pressures. Use pressure grout equipment which delivers grout to the injection point at a steady pressure.

3.03 PRESSURE GROUTING FOR PRIMARY TUNNEL AND SHAFT LINER

A. Perform grouting operations to fill voids outside of the primary tunnel or shaft liner.

B. For nonexpendable primary liners installed behind a shield or tunnel boring machine (TBM), fill voids with sand-cement grout promptly after each ring of the liner is out of the shield. Keep the grout pressure below a value that may cause damage or distortion to the installed liner plate rings. Provide seals on the tail of the shield or TBM which will prevent grout from spilling.

C. For nonexpendable primary liners installed by hand mining or in shafts, grout once every 4 feet or more frequently if conditions dictate.

D. Control grout pressures so that tunnel or shaft liner is not overstressed, and ground heave is avoided.

E. For liner requiring grout, perform back grouting once each shift, or more often if required to ensure that all voids are filled.

3.04 ANNULAR GROUTING FOR SEWER LINE IN TUNNELS AND IN CASED OR UNCASED AUGERS

A. Fill the annular space between the sewer pipe and the tunnel primary liner, casing or ground, with grout.

B. Placement

1. Placement Limits: The limits of each grout placement stage shall be predetermined by the size and capacity of the batching equipment and the initial set time of the proposed grout. Under no circumstances shall placement continue at a grout port longer than that period of time for the mix to take initial set. Grout hole spacing and locations shall be located according to the number of stages necessary to grout tunnel liners. A stage or lift cannot be installed on another lift until a proper set has been attained. Have placement procedures approved by the admixture or additive manufacturer.

2. Limit pressure on the annular space to prevent damage or distortion to the pipe or liner. Define the limiting and estimated required pressure range.

Provide an open ended, high point tap or equivalent vent and monitor it at the bulkhead opposite to the point of grouting.

3. Pump grout until a material discharging is similar in consistency to that at point of injection.

4. In a primary lined tunnel, limit length of pipe installed to 200 feet or less before grouting the same length of sewer line. Repeat this cycle until all pipe is installed and grouted.

C. Remove temporary bulkheads installed for grouting.

D. Batch and mix cellular grout mechanically to ensure consistency of the mix. Wet solids thoroughly before introduction of the foaming agent. Operate the batching system to maintain slurry weight within 3 percent of design density. Introduce foam into slurry in accordance with the manufacturer's recommendations.

3.05 PRESSURE GROUTING FOR JACKED PIPE

A. For jacked pipe 60 inches in diameter or greater, pressure grout the annulus after installation, displacing the bentonite lubrication. Jacked pipes less than 60-inch diameter may be left ungrouted unless the excavated diameter exceeds the external pipe diameter by more than one inch.

B. Inject grout through grout holes in the sewer pipe. Drilling holes from the surface or through the carrier pipe walls is not allowed. Perform grouting by injecting it at the pipe invert with bentonite displacement occurring through a high point tap or vent.

C. Control ground water as necessary to permit completion of grouting without separation of the grout materials.

D. Limit pressures to prevent damage or distortion to the pipe or to keep flexible pipe within acceptable tolerances.

E. Pump grout until material discharging is similar in consistency to that at point of injection.

3.06 GROUND STABILIZATION GROUTING

A. Completely fill voids outside the limits of excavation caused by caving or collapse of ground. Fill with gravity or pressure injected sand-cement grout as necessary to fill the void.

B. Take care in grouting operations to prevent damage to adjacent utilities or public or private property. Grout at a pressure that will not distort or damage any portion of the work or existing installations or structures.

C. Verify that the void has been filled by volumetric comparisons and visual inspection. In the case of settlement under existing slabs, take cores as directed by the Owner's Representative, at no additional cost to the Owner, to demonstrate that the void has been filled.

3.07 QUALITY CONTROL

A. Pressure Grouting for Primary Tunnel and Shaft Liners

1. For each shaft, make one set of four compressive test specimens for each 30-foot depth and one set for any remaining portion less than a 30-foot increment.

2. Make one set of four compressive test specimens for every 200 feet of primary lined, (non-expandable) tunnel requiring grout.

B. Annular Grouting for Sewer Line in Tunnels and in Cased or Uncased Augers.

1. Make one set of four compressive test specimens for every 200 feet of sewer pipe installed in primary lined tunnel.

2. For cased or uncased augers, make one set of four compressive test specimens for each grouting operation, or for each 100 feet of pipe installed, whichever is more frequent.

3. For cellular grout, check the slurry density both at point of batching and placement at least twice each hour in accordance with ASTM C138. Record density, time, and temperature. Density must be within 3 percent of design density at point of batching and 5 percent of design density at point of placement.

C. Pressure Grouting for Jacked Pipe. Make one set of four compressive test specimens for every 400 feet of jacked pipe pressure grouting.

D. Ground Stabilization Grouting.

1. Make one set of four compressive test specimens for every location where ground stabilization grouting is performed.

END OF SECTION

Section 02510

WATER MAINS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Installation of water mains, including valves, fire hydrants, wet connections, cut and plug of mains, disinfection, and hydrostatic testing for pipelines.

B. References to Technical Specifications:

1. Section 01200 - Measurement and Payment Procedures
2. Section 01350 - Submittals
3. Section 02514 - Fire Hydrant Assembly
4. Section 03300 - Cast-in-Place Concrete
5. Section 02512 - Polyethylene Wrap
6. Section 02417 - Augering Pipe for Water Lines
7. Section 02515 - Water Tap and Service Line Installation
8. Section 02318 - Excavation and Backfill for Utilities
9. Section 02980 - Pavement Repair
10. Section 01450 - Testing Laboratory Services
11. Section 02634 - Ductile Iron Pipe and Fittings

C. Referenced Standards:

1. Texas Commission on Environmental Quality (TCEQ)
2. American Water Works Association (AWWA)
3. American Society for Testing and Materials (ASTM)

1.02 MEASUREMENT AND PAYMENT

A. Measurement for water mains open cut or augered, with or without casing is on a linear foot basis for each size of pipe installed.
Mains: Measure along axis of pipe and include fittings and valves.
Branch Pipe: Measure from axis of main to end of branch.

B. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Pipe shall bear Underwriter's Laboratories (UL) or Factory Mutual (FM) label.

2. Pipe material acceptable without penalty to State's community fire insurance rating agency.

3. System acceptable to City and TCEQ.

4. Bacteriological disinfection acceptable to local health officials and Texas Department of Health, and TCEQ.

5. Water taps and draws off lines in compliance with local municipal specifications and regulations.

1.04 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Product Data:

1. Obtain from pipe manufacturer installation instructions, manuals, and printed recommendations, except for Owner furnished pipe.

2. Retain product data on job site for reference.

3. Submit certified record of tests of pipe, fittings, or valves upon request of Engineer.

4. Submit hydrant manufacturer flow and friction loss curve.

C. Samples:

1. Notify City when system is pressure tested and disinfected. City will take all samples for bacteriological testing as required by TCEQ.

1.05 PRODUCT HANDLING

A. Deliver pipe to trench in sound, undamaged condition.

B. Cut pipe neatly avoiding sharp, ragged, or unbeveled, plain ends and do not damage lining by cutting.

C. Remove damaged or rejected materials from project site.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not lay pipe when it is raining or when trench is muddy, soft, or contains standing water.

2.0 PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

A. Conform to requirements of Section 02534 - PVC Pipe. All pipe used for water mains shall be blue.

2.02 HIGH DENSITY POLYETHYLENE

A. Conform to requirements of Section 02532W - HDPE

2.03 STEEL PIPE AND FITTINGS FOR LARGE DIAMETER WATER LINES

A. Conform to requirements of Section 02513 - Steel Pipe and Fittings for Large Diameter Water Lines.

2.04 DUCTILE IRON PIPE AND FITTINGS

A. Conform to requirements of Section 02634 - Ductile Iron Pipe and Fittings.

2.05 FIRE HYDRANTS

A. Conform to requirements of Section 02514 - Fire Hydrant Assembly.

2.06 VALVES

A. General: Conform to requirements of Section 02541 – Water and Wastewater Line Valves.

1. Manual operators:
   a. Provide hand wheel manual operators for in-plant valves.
   b. Equip buried valves with 2 in. square operating nuts.
2. Furnish no less than one operating key with each lot of 10 buried valves with nut operators.
3. Rotation:
   a. Direction: OPEN COUNTERCLOCKWISE (OPEN LEFT).
4. Shop coating:
   a. Shop coat ferrous metal surfaces of valves both interior and exterior for corrosion protection.
   b. Protect internal and external iron surfaces of valves with coating of 4 mils of two-part thermosetting epoxy: AWWA C 550.
5. Working and test pressures:
   a. Valves 2 in. through 12 in.: 200 psi working pressure, 400 psi hydrostatic test pressure.
   b. Valves 14 in. through 36 in.: 150 psi working pressure, 300 psi hydrostatic test pressure.

B. Gate Valves (2 in. Through 36 in.):

1. Buried valves:

a. Comply with AWWA C500, non-rising stem (NRS); resilient wedge.

b. Epoxy-coated ductile iron body and bonnet, inside screw.

c. Bronze: Seat and disc rings, stem and mountings, and disc wedges.

d. "O" ring sealed stem and 2 in. square operating nut.

e. Valves 2 in. through 12 in.: Vertical type without by-passes.

f. Valves 16 in. through 36 in.: Horizontal type with enclosed steel bevel gears resilient wedge, standard size by-pass valves.

g. Stuffing box and bonnet bolts and nuts to be 304 stainless steel.

h. Install in section of horizontal pipe.

i. Mechanical joint ends with gasket complying with AWWA C 111.

j. Acceptable product:
1) East Jordan, American Flow Control, Mueller Co. “A-2380 Series"

C. Tapping Valves and Tapping Sleeves:

1. Tapping sleeves shall be solid stainless steel and valves shall conform with all others as mentioned above.

D. Valve Boxes:

1. Cast iron, threaded screw extension sleeve type, adjustable suitable for depth of cover over pipe, with base and cover.

2. 3/16 in. thick, 5 in. diameter minimum.

3. Provide with suitable cast iron bases and covers.

4. Covers: Cast name designating type of service, e.g., "WATER" for water service.

2.07 RELATED MATERIALS

A. Concrete: As specified in Section 03300 – Cast-in-Place Concrete.

B. Meter Box:
   1. Cast iron to Owner's dimensions: ASTM A 48.

C. The service line between Curb stop and Corporation Stop shall be CTS Polyethylene, SDR – 9.

D. Corporation and Curb Stops and Fittings: ASTM B 62, NSF 61 lead free

3.0 EXECUTION

A. Conform to requirements in Section 02534 - PVC Pipe, Section 02634 - Ductile Iron Pipe and Fittings, Section 02532W – HDPE, Section 02635 Steel Pipe and Fittings, and Section 02513 - Steel Pipe and Fittings for Large Diameter Water Lines.

3.02 PREPARATION

A. Thoroughly clean pipe interiors of foreign matter before being lowered into trench.

B. Clean hydrant and valve interiors of foreign matter before installation.

C. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished. Provide watertight pipe and pipe joints.

D. Lay pipe to lines and grades shown on Drawings and Details.

E. If asbestos-cement (A.C.) pipe is encountered, follow safety practices outline in American Water Works Association's publication, "Work Practices for A/C Pipe". Strictly adhere to "recommended practices" contained in this publication and make them "mandatory practices" for this project.

F. For pipe diameters 36 inches and greater, clearly mark each section of pipe and fitting with unique designation on inside of pipe along with pressure class. Locate unique identifying mark minimum of five feet away from either end of each section of pipe. Provide one unique identifying mark in middle of each fitting. Place markings at consistent locations. Use permanent black paint and minimum letter height of 4 inches to mark designations.

G. Contractor is responsible for assuring chosen manufacturer fulfills requirements for extra fittings and, therefore, is responsible for costs due to downtime if requirements are not met.

3.03 INSTALLATION

A. Inspection:

   1. Carefully examine each piece of pipe for soundness and specifications compliance after delivery at trench before placing in trench.

2. Remove rejected pipe and fittings from site of work and replace with sound pipe.

3. Pipe and fittings will be rejected because of any of the following:

   a. Cracks in pipe or fittings.
   b. Damaged or cracked ends.
   c. Damaged gaskets or gasket grooves.
   d. Less than minimum wall thickness.
   e. Defects and deformations.

B. Cleaning:

1. Clean interior of pipe and fittings of foreign matter before laying.

2. Keep interiors and ends clean during installation.

3. Keep joint contact surfaces clean during installation.

4. Take precautions to prevent foreign material from entering pipe during installation.

5. Do not place rubbish, tools, rags, or other materials in pipe.

6. Whenever pipe laying is stopped, place plugs in uncompleted ends of pipe.

C. Installation:

1. Install pipe, couplings, and fittings in accordance with pipe manufacturer's recommendations. Conform to applicable installation specifications for types of pipes use.

2. Install gaskets and lubricants as recommended by manufacturer.

3. Full length of each barrel of pipe shall rest solidly on pipe bed with recesses excavated to accommodate bells and joints.

4. Take up and relay pipe that has grade or joint disturbed.

5. Do not joint pipe with water in trench.

6. Keep water out of trench until jointing is completed.

7. Do not lay water pipe closer than 10 ft. horizontally from sanitary sewer.

8. Do not locate joints at cross-overs with sanitary sewers closer than 9 ft. from cross-over point.

9. Where water lines cross sanitary sewers, construct in accordance with the City of Baytown Engineering Design Criteria Manual for water line or TCEQ standards whichever is more stringent10. Where pipe ends are left for future connections, install valve and plug or cap end. Forty feet minimum line section required between valves and plug or cap end.

11. Install concrete thrust blocking at bends and tees and at ends of lines to provide adequate reaction backing.

12. Lay not more than 100 feet of pipe in trench ahead of backfilling operations.

13. Dig trench proper width as shown in details. When trench width below top of pipe becomes 4 feet wider than specified, install higher class of pipe or improved bedding, as determined by Engineer. No additional payment will be made for higher class of pipe or improved bedding.

14. Use adequate surveying methods and equipment; employ personnel competent in use of this equipment. Horizontal and vertical deviations from alignment as indicated on Drawings shall not exceed 0.10 feet. Measure and record "as built" horizontal alignment and vertical grade at maximum of every 100 feet on record drawings.

15. Before assembling couplings, lightly coat pipe ends and outside of gaskets per manufacturer's specification.

16. Prevent damage to coating when placing backfill. Use backfill material free of large rocks or stones, or other material which could damage coatings.

D. Setting Valves, Valve Boxes and Fire Hydrants:

1. Set plumb.

2. Center valve boxes on valves.

3. Where feasible, locate valves outside area of roads and streets.

4. Carefully tamp back fill around each valve box to distance of 4 ft. on all sides or to undisturbed trench face if less than 4 ft.

5. Set hydrants at elevation so that connecting pipe will not have less cover than mains.

6. Set hydrants on concrete pad.

7. Depth of bury of hydrant is defined as distance from bottom of inlet pipe to ground line.

8. Place concrete thrust block back of hydrant opposite pipe connections set against vertical face of trench to prevent from blowing off line.

9. Use 5/8 in. stock stainless steel bridle rods and rod collars.

10. Place not less than 5 cu. ft. of broken stone around base of hydrant to ensure drainage.

11. Compact backfill to grade in accordance with specification section 02318 – Excavation and Backfill for Utilities

12. Tighten stuffing boxes.

13. Test hydrant and valve in opened and closed position to ensure that parts are in working condition.

E. Joints and Jointing:

1. Rubber Gasketed Bell-and-Spigot Joints for PVC, Steel, and Ductile Iron Pipe:

2. a. After rubber gasket is placed in spigot groove of pipe, equalize rubber gasket cross section by inserting tool or bar recommended by manufacturer under rubber gasket and moving it around periphery of pipe spigot.

b. Lubricate gaskets per manufacturer's specification.

c. Fit pipe units together in manner to avoid twisting or otherwise displacing or damaging rubber gasket.

d. After pipe sections are joined, check gaskets to ensure that no displacement of gasket has occurred. If displacement has occurred, remove pipe section and remake joint as for new pipe. Remove old gasket, inspect for damage and replace if necessary before remaking joint.

e. Where preventing movement of 16-inch diameter or greater pipe is necessary due to thrust, use restrained joints as shown on Drawings.

1) Include buoyancy conditions for soil unit weight when computing thrust restraint calculations.

2) Do not include passive resistance of soil in thrust restraint calculations.

f. Except for PVC pipe, provide means to prevent full engagement of spigot into bell as shown on Drawings. Means may consist of wedges or other types of stops as approved by Engineer.

2. Flanged Joints where required on Ductile Iron Pipe, or Steel Pipe:

   a. AWWA C 207. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical pre-stressing of flanges, pipe and equipment. Align bolt holes to straddle vertical, horizontal or north-south center line. Do not exceed 3/64 inch per foot inclination of flange face from true alignment.

   b. Use full-face gaskets for flanged joints. Provide 1/8-inch-thick cloth inserted rubber gasket material. Cut gaskets at factory to proper dimensions.

   c. Use stainless steel nuts and bolts to match flange material. Use stainless steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Maintain at all times approximately same distance between two flanges at points around flanges. Tighten bolts alternately (180° apart) until all are evenly tight. Draw bolts tight to ensure proper seating of gaskets.

   d. Full length bolt isolating sleeves and washers shall be used with flanged connections.

   e. For in-line flange joints 30 inches in diameter and greater and at butterfly valve flanges, provide Pyrox G-10 with nitrite seal, conforming to ANSI A 21.11 mechanical joint gaskets. For in-line flange joints sized between 12 inches in diameter and greater and 24 inches in diameter and smaller, provide Phenolic PSI with nitrite seal gasket conforming to ANSI A 21.11 mechanical joint gaskets.

3. Welded Joints (Steel Pipe):

   a. Prior to starting work, provide certification of qualification for welders employed on project for type of work procedures and positions involved.

   b. Joints: AWWA C 206. Full-fillet, single lap-welded slip-type either inside or outside, or double butt-welded type; use automatic or hand welders; completely penetrate deposited metal with base metal; use filler metal compatible with base metal; keep inside of fittings and joints free from globules of weld metal which would restrict flow or become loose. Do not use mitered joints. For interior welded joints, complete backfilling before welding. For exterior field-welded joints, provide adequate working room under and beside pipe. Use exterior welds for 30-inch and smaller.

c. Furnish welded joints with trimmed spigots and interior welds for 36-inch and larger pipe.

d. Bell-and-spigot, lap-welded slip joints: Deflection may be taken at joint by pulling joint up to 3/4 inch as long as 1 ½ inch minimum lap is maintained. Spigot end may be miter cut to take deflections up to 5 degrees as long as joint tolerances are maintained. Miter end cuts of both ends of butt-welded joints may be used for joint deflections of up to 5 degrees.

e. Align piping and equipment so that no part is offset more than 1/8 inch. Set fittings and joints square and true, and preserve alignment during welding operation. For butt welded joints, align abutting ends to minimize offset between surfaces. For pipe of same nominal wall thickness, do not exceed 1/16 inch offset. Use line-up clamps for this purpose; however, take care to avoid damage to linings and coatings.

f. Protect epoxy or cement lining during welding by draping an 18-inch wide strip of heat resistant material over top half of pipe on each side of lining holdback to avoid damage to lining by hot splatter. Protect tape coating similarly if external welding is required.

g. Welding rods: Compatible with metal to be welded to obtain strongest bond, E-7018. Root or "Stringer" pass shall be performed with 6011 rods and Filler and Cap shall be done using 7018 rods.

h. Deposit metal in successive layers to provide at least 2 passes or beads for automatic welding and 3 passes or beads for manual welding in completed weld.

i. Deposit no more than 1/4 inch of metal on each pass. Thoroughly clean each individual pass with wire brush or hammer to remove dirt, slag or flux.

j. Do not weld under weather condition that would impair strength of weld, such as wet surface, rain or snow, dust or high winds, unless work is properly protected.

k. Make tack weld of same material and by same procedure as completed weld. Otherwise, remove tack welds during welding operation.

l. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, or valves.

m. Welded Joints for Large Diameter Water Lines:

1) Furnish pipe with trimmed spigots and interior welds for 36 inch and larger pipe.

2) Use exterior welds for 30 inch and smaller.

3) Only one end may be miter cut. Miter end cuts of both ends of butt-welded joints may be used for joint deflections of up to 2 ½ degrees.

4) For large diameter water lines, employ an independent certified testing laboratory, approved by Engineer, to perform weld acceptance tests on welded joints. Include cost of such testing and associated work to accommodate testing in contract unit price bid for water line. Furnish copies of test reports to Engineer for review. Engineer has final decision as to suitability of welds tested.

A) Weld acceptance criteria:
   i) Cracking.
   ii) Lack of fusion/penetration.
   iii) Slag which exceeds one-third (t) where (t) equals material thickness.
   iv) Porosity/Relevant rounded indications greater than 3/16 inch; rounded indication is one of circular or elliptical shape with length equal to or less than three times its width.
   v) Relevant linear indications in which length of linear indication exceeds three times its width.
   vi) Four or more relevant 1/16 inch rounded indications in line separated by 1/16 inch or less edge to edge.

n. After pipe is joined and prior to start of welding procedure, make spigot and bell essentially concentric by jacking, shimming or tacking to obtain clearance tolerance around periphery of joint except for deflected joints.

o. Furnish each welder employed steel stencil for marking welds, so work of each welder can be identified. Mark pipe with assigned stencil adjacent to weld. When welder leaves job, stencil must be voided and not duplicated. Welder making defective welds must discontinue work and leave project site. Welder may return to project site only after recertification

p. Provide cylindrical corrosion barriers for epoxy lined steel pipe 24 inch diameter and smaller, unless minimum wall thickness is 0.5 inches or greater.

1) In additional to welding requirements contained herein Paragraph 3.06; conform to protection fitting manufacturer's installation recommendations.

2) Provide services of technical representative of manufacturer available on site at beginning of pipe laying operations. Representative to train welders and advice regarding installation and general construction methods. Welders must have 12 months prior experience installing protection fittings.

3) All steel pipe is to have cutback 3/4 inch to no greater than 1 inch of internal diameter coating from weld bevel.

4) Furnish steel fittings with cylindrical corrosion barriers with shop welded extensions to end of fittings. Extension length to measure no less than diameter of pipe. Shop applies lining in accordance with AWWA C210 or AWWA C213.

5) All steel pipe receiving field adjustments are to be cold cut using standard practices and equipment. No cutting using torch is to be allowed.

4. Restrained Joints:

a. For existing water lines and water lines less than 16 inches in diameter, restrain pipe joints with concrete thrust blocks.

b. Thrust restraint lengths shown on Drawings are minimum anticipated lengths. These lengths are based on deflections indicated for large diameter lines and ductile iron pipe for small diameter lines. Adjustments in deflections or use of other pipe material may result in reduction or increase of thrust lengths. Perform calculations by pipe manufacturer to verify proposed thrust restraint lengths. Submit calculations for all pipe materials sealed by a registered Professional Engineer in State of Texas for review by Engineer. Make adjustments in thrust restraint lengths at no additional cost to City.

c. Passive resistance of soil will not be permitted in calculation of thrust restraint.

d. For 16 inch lines and larger use minimum 16 foot length of pipe in and out of joints made up of beveled pipe where restraint joint lengths are not identified on Drawings. Otherwise, provide restraint joints for a minimum length of 16 feet on each side of beveled joints.

e. Installation:

1) Install restrained joints mechanism in accordance with manufacturer's recommendations.

2) Examine and clean mechanism; remove direct, debris and other foreign material.

3) Apply gasket and joint NSF 61 FDA per manufacturer's specification.

4) Verify gasket is evenly seated.

5) Do not over stab pipe into mechanism

f. Prevent any lateral movement of thrust restraints throughout pressure testing and operation.

g. Place 2500 psi concrete conforming to Section 03315 - Concrete for Utility Construction, for blocking at each change in direction of existing water lines, to brace pipe against undisturbed trench walls. Finish placement of concrete blocking, made from Type I cement, 4 days prior to hydrostatic testing of pipeline. Test may be made 2 days after completion of blocking if Type II cement is used.

5. Joint Grout (Steel Pipe):

a. Mix cements grout mixture by machine except when less than 1/2 cubic yard is required. When less than 1/2 cubic yard is required, grout may be hand mixed. Mix grout only in quantities for immediate use. Place grout within 20 minutes of mixing. Discard grout that has set. Retempering of grout by any means is not permitted.

b. Prepare grout in small batches to prevent stiffening before it is used. Do not use grout which has become so stiff that proper placement cannot be assured without retempering. Use grout for filling grooves of such consistency that it will adhere to ends of pipe.

c. Surface Preparation: Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces with wire brush or hammer to sound, clean surface. Remove rust and foreign materials from metal surfaces in contact with grout.

d. Follow established procedures for hot and cold weather concrete placement.

e. Complete joint grout operations and backfilling of pipe trenches as closely as practical to pipe laying operations. Allow grouted exterior joints to cure at least 1 hour before compacting backfill.

f. Grouting exterior joint space: Hold wrapper in place on both sides of joint with minimum 5/8-inch-wide steel straps or bands. Place no additional bedding or backfill material on either side of pipe until after grout band is filled and grout has mechanically stiffened. Pull ends of wrapper together at top of pipe to form access hole. Pour grout down one side of pipe until it rises on other side. Rod or puddle grout to ensure complete filling of joint recess. Agitate for 15 minutes to allow excess water to seep through joint band. When necessary, add more grout to fill joint completely. Protect gap at top of joint band from backfill by allowing grout to stiffen or by covering with structurally protective material. Do not remove band from joint. Proceed with placement of additional bedding and backfill material.

g. Interior Joints for Pipe 24 inches and Smaller: Circumferentially butter bell with grout prior to insertion of spigot, strike off flush surplus grout inside pipe by pulling filled burlap bag or inflated ball through pipe with rope. After joint is engaged, finish off joint grout smooth and clean. Use swab approved by Project Manager for 20-inch pipe and smaller.

h. Protect exposed interior surfaces of steel joint bands by metallizing, by other approved coatings, or by pointing with grout. Joint pointing may be omitted on potable water pipelines if joint bands are protected by zinc metalizing or other approved protective coatings.

i. Remove and replace improperly cured or otherwise defective grout.

j. Strike off grout on interior joints and make smooth with inside diameter of pipe.

k. When installed in tunnel or encasement pipe and clearance within casing does not permit outside grout to be placed in normal manner, apply approved flexible sealer, such as Flex Protex or equal, to outside joint prior to joint engagement. Clean and prime surfaces receiving sealer in accordance with manufacturer's recommendations. Apply sufficient quantities of sealer to assure complete protection of steel in

joint area. Fill interior of joint with grout in normal manner after joint closure.

l. Interior Joints for Water Lines 30 inches and Larger: Clean joint space, wet joint surfaces, fill with stiff grout and trowel smooth and flush with inside surfaces of pipe using steel trowel so that surface is smooth. Accomplish grouting at end of each work day. Obtain written acceptance from Project Engineer of inside joints before proceeding with next day's pipe laying operation. During inspection, insure no delamination of joint mortar has occurred by striking joint mortar lining with rubber mallet. Remove and replace delaminated mortar lining.

m. Work which requires heavy equipment to be over water line must be completed before mortar is applied to interior joints.

n. Do not apply grout to joints that are out of tolerance until acceptable repairs are made.

6. Large Diameter Water Main Joint Testing: In addition to testing individual joints with feeler gauge approximately 1/2 inch wide and 0.015-inch thick, use other joint testing procedure approved or recommended by pipe manufacturer which will help ensure watertight installation prior to backfilling. Perform tests at no additional cost to City.

7. Make curves and bends by deflecting joints or other method as recommended by manufacturer and approved by the Engineer. Submit details of other methods of providing curves and bends which exceed manufacturer's recommended deflection prior to installation.

a. Deflection of pipe joints shall not exceed maximum deflection recommended by pipe manufacturer, unless otherwise indicated on Drawings.

b. If deflection exceeds that specified but is less than 5 percent, repair entire deflected pipe section such that maximum deflection allowed is not exceeded.

c. If deflection is equal to or exceeds 5 percent from that specified, remove entire portion of deflected pipe section and install new pipe.

d. Replace, repair, or reapply coatings and linings as required.

e. Assessment of deflection may be measured by the Engineer at location along pipe. Arithmetical averages of deflection or similar average measurement methods will not be deemed as meeting intent of standard.

f. When rubber gasketed pipe is laid on curve, join pipe in straight alignment and then deflect to curved alignment.

8. Closures Sections and Approved Field Modifications to Steel Pipe and Fittings:

a. Apply welded-wire fabric reinforcement to interior and exterior of exposed interior and exterior surfaces greater than 6 inches in diameter. Welded-wire fabric: minimum W1; maximum spacing 2 inches by 4 inches; 3/8 inch from surface of steel plate or middle third of lining or coating thickness for mortar thickness less than 3/4 inch.

b. Fill exposed interior and exterior surfaces with nonshrink grout.

c. For pipe diameters 36 inches and greater, perform field welds on interior and exterior of pipe.

d. For large diameter water lines, provide minimum overlap of 4 inches of butt strap over adjacent piece on butt-strap closures.

F. Cathodic Protection Appurtenances:

1. Where identified on Drawings, modify pipe for cathodic protection as detailed on Drawings and specified. Unless otherwise noted, provide insulation kits including test stations at connections to existing water system or at locations to isolate one type of cathodic system from another type, between water line, access manhole piping and other major openings in water line, or as shown on Drawings.

2. Bond joints for pipe installed in tunnel or open cut, except where insulating flanges are provided. Weld strap or clip between bell and spigot of each joint or as shown on Drawings. No additional bonding required where joints are welded for thrust restraint. Repair coatings as specified by appropriate AWWA standard, as recommended by manufacturer, and as approved by the Engineer

3. Bonding Strap or Clip: Free of foreign material that may increase contact resistance between wire and strap or clip.

G. Anchorage of Fittings:

1. Anchor tees, elbows and plugs in water mains with concrete thrust blocks.

2. Place blocks so that joints will be accessible for inspection and repair.

H. Handling:

1. Place pipe along project site where storm water or other water will not enter or pass through pipe.

2. Load, transport, unload, and otherwise handle pipe and fittings to prevent damage of any kind. Handle and transport pipe with equipment designed, constructed and arranged to prevent damage to pipe, lining and coating. Do not permit bare chains, hooks, metal bars, or narrow skids or cradles to come in contact with coatings. Where required, provide pipe fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.

3. Hoist pipe from trench side into trench by means of sling of smooth steel cable, canvas, leather, nylon or similar material.

4. For large diameter water lines, handle pipe only by means of sling of canvas, leather, nylon, or similar material. Sling shall be minimum 36 inches in width. Do not tear or wrinkle tape layers.

5. Use precautions to prevent injury to pipe, protective linings and coatings.

   a. Package stacked pipe on timbers. Place protective pads under banding straps at time of packaging.

   b. Pad fork trucks with carpet or other suitable material. Use nylon straps around pipe for lift when relocating pipe with crane or backhoe.

   c. Do not lift pipe using hooks at each end of pipe.

   d. Do not place debris, tools, clothing, or other materials on pipe.

6. Repair damage to pipe or protective lining and coating before final acceptance.

7. For cement mortar line and coated steel pipe, permit no visible cracks longer than 6 inches, measured within 15 degrees of line parallel to pipe longitudinal axis of finished pipe, except:

   a. In surface laitance of centrifugally cast concrete.
   b. In sections of pipe with steel reinforcing collars or wrappers.
   c. Within 12 inches of pipe ends.

8. Reject pipe with visible cracks (not meeting exceptions) and remove from project site.

I. Cleaning: Thoroughly clean and dry interior of pipe and fittings of foreign matter before installation, and keep interior clean until Work has been accepted. Keep joint contact surfaces clean until jointing is completed. Do not place debris, tools, clothing or other materials in pipe. After pipe laying and joining operations are completed, clean inside of pipe and remove debris.

J. Inspection: Before installation, inspect each pipe and fitting for defects. Reject defective, damaged or unsound pipe and fittings and remove them from site.

3.04 WET CONNECTIONS

A. Definitions:

1. Wet connections consist of isolating sections of pipe to be connected with installed valves, draining the isolated sections, and completing the connections.

2. Connection of 2 inch or smaller lines, which may be referred to on Plans as "2 inch standard connections" or "gooseneck connections" will be measured as 2" wet connections. This item is not to be used as any part of a 2-inch service line.

B. Materials:

1. Corporation stops and saddles shall conform to requirements of Section 02515-Water Tap and Service Line Installation.

2. Valves shall conform to requirements of Section 02541 – Fire Hydrant Assembly.

3. Brass fittings shall conform to requirements of AWWA C800.

C. Execution:

1. Plan wet connections in such manner and at such hours as to least inconvenience public. Notify Public Works Department at least 48 hours in advance of making connections.

2. DO NOT OPERATE VALVES ON MAINS IN USE BY OWNER. Owner will handle, at no cost to Contractor, all operations involving opening and closing valves for wet connections.

3. Conduct connection operations when Inspector is at job site. Connection work shall progress without interruption until complete, once existing mains have been cut or plugs have been removed for making connections.

D. 2-Inch Wet Connections:

1. Tap water main. Provide and install corporation stops, saddles, as required for line and grade adjustment; and brass fittings necessary to adapt to existing main. Provide one Corporation Stop at main line and one Curb Stop at meter. The service line between Curb Stop and Corporation Stop shall be CTS Polyethylene, SDR-9.

3.05 CUT, PLUG AND ABANDONMENT OF MAINS

A. Materials:

1. Concrete for thrust blocks: Class B conforming to requirements of Section 03305.

2. Plugs and clamps shall be suitable for type of pipe to be plugged.

B. Execution:

1. Do not begin cut, plug and abandonment operations until replacement main has been constructed, disinfected, and tested, and all service lines have been transferred to replacement main.

2. Install plug, clamp, and concrete thrust block and make cut at location shown on Plans.

3. Main to be abandoned shall not be valved off and shall not be cut or plugged other than at supply main or as shown on Plans.

4. After main to be abandoned has been cut and plugged, check for other sources feeding abandoned main. If sources are found, notify Engineer immediately. Cut and plug abandoned main at point of other feed as directed by Engineer.

5. Plug or cap all ends or openings in abandoned main in an acceptable manner approved by Engineer.

6. Remove and dispose of all surface identifications such as valve boxes and fire hydrants. Valve boxes in improved streets, other than shell, may be poured full of concrete after removing cap.

7. Backfill all excavations in accordance with Section 02318 – Excavation and Backfill for Utilities.

8. Repair all street surfaces in accordance with Section 02980 – Pavement Repair.

3.06 HYDROSTATIC TESTING

A. Hydrostatically test all new water pipelines for liquids before connecting to water distribution system.

B. Pipelines shall be tested in lengths between valves, or plugs, of not more than 1,500 feet unless greater length is approved by Engineer.

C. Conduct hydrostatic tests in presence of Engineer.

D. Preparation:

1. Disinfect water system pipelines prior to hydrostatic testing.

E. Test Procedures:

1. Furnish, install, and operate connections, pump, meter and gages necessary for hydrostatic testing.

2. Allow pipeline to sit minimum of 24 hours from time it is initially disinfected until testing begins, to allow pipe wall or lining material to absorb water. Contractor should be aware that periods of up to 7 days may be required for mortar lining to become saturated.

3. Expel all air and apply a minimum test pressure of 125 psi or 150 psi as directed by Engineer.

4. Maintain test pressure for 8 hours. If a large quantity of water is required to maintain pressure during test, testing shall be discontinued until cause of water loss is identified and corrected.

F. Allowable Leakage for Water Mains:

1. During hydrostatic tests, no leakage will be allowed for sections of water mains consisting of welded joints.

2. Maximum allowable leakage for water mains with rubber gasketed joints: 11.65 gallons per inch nominal diameter per mile of pipe per 24 hours while testing at the required pressure.

G. Correction for Failed Tests:

1. Repair all joints showing visible leaks on surface regardless of total leakage shown on test. Check all valves and fittings to ensure that no leakage occurs that could affect or invalidate test. Remove any cracked or defective pipes, fittings and valves discovered during pressure test and replace with new items.

2. Repeat test until satisfactory results are obtained.

3.07 DISINFECTION

A. All waterlines constructed shall be promptly disinfected before any tests are conducted on waterlines and before waterlines are connected to water distribution system.

B. Water for disinfection and flushing will be furnished without charge to Contractor.

C. Preparation:

1. Furnish all required temporary blind flanges, cast-iron sleeves, plugs, and other items needed to facilitate disinfection of new mains prior to connecting them to water distribution system. Normally, each valved section of waterline requires two each 3/4-inch taps. A 2-inch minimum blow-off is required for waterlines up to and including 6-inch diameter.

2. .Fire hydrants shall be used as blow-offs to flush newly constructed waterlines 8-inch diameter and above. Where fire hydrants are not available on waterlines, locations and designs for blow-offs shall be as indicated on Plans. Install temporary blow-off valves and remove promptly upon successful completion of disinfection and testing. Abandon by turning off corp and using a stainless steel cap.

3. Slowly fill each section of pipe with water in a manner approved by Engineer. Average water velocity when filling pipeline should be less than 1 fps and shall not, under any circumstance, exceed 2 fps. Before beginning disinfection operations, expel all air from pipeline.

4. All excavations made shall be backfilled immediately after installation of risers or blow-offs.

5. Install blow-off valves at end of main to facilitate flushing at all dead-end water mains. Install permanent blow-off valves/auto flusher per drawing Ll

D. Disinfection:

1. Use not less than 100 parts of chlorine per million parts of water. Introduce chlorinating material to water lines in accordance with AWWA C651. After contact period of not less than 24 hours, flush system with clean water until residual chlorine is no greater than 1.0 parts per million parts of water. Open and close valves in lines being sterilized several times during contact period. If super-chlorinated water (i.e. chlorine concentration above 4mg/l) is used for cleaning water main disinfection and flushing, the water must be dechlorinated prior to discharge. The water discharged into the stormsewer system or natural waterway must meet the Clean Water Act (33 USC § 1251 et seq.) and any subsequent amendments thereof.
2. If a chemical compound is used for a sterilizing agent, it shall be placed in pipes as directed by Engineer.

E. Bacteriological Testing:

1. After disinfection and flushing of waterlines, bacteriological tests will be performed by Owner or testing laboratory in accordance with Section 01450 – Testing Laboratory Services. If test results indicate need for additional disinfection of waterlines based upon Texas Department of Health and TCEQ requirements, Contractor shall perform additional disinfection operations at no additional cost to the Owner.

E. Completion:

1. Upon completion of disinfection and testing, remove risers except those approved for use in subsequent hydrostatic testing, and backfill excavation promptly.

END OF SECTION

Section 02511

WATER METERS

1.0 GENERAL

1.01 SECTION INCLUDES

A Water meters for customer service, including submeters (i.e., cooling tower meters, sewer credit meters, etc.), for fire service in sizes 5/8 inch through 10 inches.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment
2. Section 02510 – Water Mains
3. Section 02541 – Water and Wastewater Line Valves

1.02 MEASUREMENT AND PAYMENT

A Measurement for installation of water meters furnished by the Owner is on an each basis for each meter type and size. Payment includes all labor and materials required for installation of water meters furnished by the Owner as indicated on Plans.

B Refer to Section 01200 – Measurement and Payment Procedures.

2.0 PRODUCTS

2.01 GENERAL

A Water meters shall be furnished by the Owner.

2.02 CONNECTIONS AND FITTINGS

A Connections: Provide pipe in accordance with Section 02510 – Water Mains, restrained joints only.

B Fittings: Restrained ductile iron; push-on bell joints or mechanical joint fittings outside of meter vault installations; Class 125 flanged inside meter vaults; cement mortar lined and sealed.

2.03 LAYING LENGTHS

A The minimum length (with 1 inch tolerance) for meter and standard strainer shall be shown as indicated on the detail drawing for water meters.

3.0 EXECUTION

3.01 TAPPING AND SERVICE LINE INSTALLATION

A Refer to Section 02541 – Water and Wastewater Line Valves for tapping requirements.

END OF SECTION

Section 02512

POLYETHYLENE WRAP

1.0 GENERAL

1.01 SECTION NCLUDES

A Polyethylene wrap for cast and ductile iron pipe to be used only in open-cut construction when cathodic protection system is not required by Plans.

B References to Technical Specifications:
1. Section 01350 – Submittals

C Referenced Standards:
1. American Water Works Association (AWWA)
   a. AWWA C105 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
2. American Society of Testing and Materials (ASTM)
   a. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for polyethylene wrap. Include cost of polyethylene wrap in unit price for items wrapped.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit manufacturer's product data for proposed film and tape for approval.

2.0 PRODUCTS

2.01 MATERIALS

A Polyethylene Film: Tubular or sheet form without tears, breaks, holidays or defects; conforming with requirements of AWWA C105, 2.5 to 3 percent carbon black content, either low- or high-density:
1. Low-density polyethylene film. Low-density polyethylene film shall be manufactured of virgin polyethylene material conforming to the following requirements of ASTM D 1248.
   a. Raw material.
      1) Type : I
      2) Class: C (black)
      3) Grade: E-5

4) Flow rate (formerly melt index): 0.4 g/10 minute, maximum
5) Dielectric strength: Volume resistivity, 10^{15} ohm-cm, minimum

b. Physical properties.
1) Tensile strength: 1200 psi, minimum
2) Elongation: 300 percent, minimum
3) Dielectric strength: 800 V/mil thickness, minimum

c. Thickness: Low-density polyethylene film shall have a nominal thickness of 0.008 inch. The minus tolerance on thickness is 10 percent of the nominal thickness.

2. High-density, cross-laminated polyethylene film: High-density, cross laminated polyethylene film shall be manufactured of virgin polyethylene material conforming to the following requirements of ASTM D 1248

a. Raw material.
1) Type: III
2) Class: C (black)
3) Grade: P33
4) Flow rate (formerly melt index): 0.4 to 0.5g/10 minute, maximum
5) Dielectric strength: Volume resistivity, 10^{15} ohm-cm, minimum

b. Physical properties.
1) Tensile strength: 5000 psi, minimum
2) Elongation: 100 percent, minimum
3) Dielectric strength: 800 V/mil thickness, minimum

c. Thickness: Film shall have a nominal thickness of 0.004 inch. The minus tolerance of thickness is 10 percent of the nominal thickness.

B Polyethylene Tape: Provide 3-inch wide, plastic-backed, adhesive tape; Polyken No. 900, Scotchwrap No. 50, or equal.

3.0 EXECUTION

3.01 INSTALLATION

A Preparation:

1. Remove all lumps of clay, mud, cinders, etc., on pipe surface prior to installation of polyethylene encasement. Prevent soil or embedment material from becoming trapped between pipe and polyethylene.
2. Fit polyethylene film to contour of pipe to affect a snug fit, but not tight; encase with minimum space between polyethylene and pipe. Provide sufficient slack in contouring to prevent stretching polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces, bolted joints or fittings, and to prevent damage to polyethylene due to backfilling operations. Secure overlaps and ends with adhesive tape to hold polyethylene encasement in place until backfilling operations are complete.

3. For installations below water table and/or in areas subject to tidal actions, seal both ends of polyethylene tube with adhesive tape at joint overlap.

B Tubular Type (Method A):

1. Cut polyethylene tube to length approximately 2 feet longer than pipe section. Slip tube around pipe, centering it to provide 1-foot overlap on each adjacent pipe section, and bunching it accordion-fashion lengthwise until it clears pipe ends.
2. Lower pipe into trench and make up pipe joint with preceding section of pipe. Make shallow bell hole at joints to facilitate installation of polyethylene tube.
3. After assembling pipe joint, make overlap of polyethylene tube. Pull bunched polyethylene from preceding length of pipe, slip it over end of new length of pipe, and secure in place. Then slip end of polyethylene from new pipe section over end of first wrap until it overlaps joint at end of preceding length of pipe. Secure overlap in place. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points.
4. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

C Tubular Type (Method B):

1. Cut polyethylene tube to length approximately 1 foot shorter than pipe section. Slip tube around pipe, centering it to provide 6 inches of bare pipe at each end. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points; secure ends.
2. Before making up joint, slip 3-foot length of polyethylene tube over end of preceding pipe section, bunching it accordion-fashion lengthwise. After completing joint, pull 3-foot length of polyethylene over joint, overlapping polyethylene previously installed on each adjacent section of pipe by at least 1 foot; make each end snug and secure.
3. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

D Sheet Type:

1. Cut polyethylene sheet to a length approximately 2 feet longer than pipe section. Center length to provide 1-foot overlap on each adjacent pipe section, bunching it until it clears pipe ends. Wrap polyethylene around pipe so that it circumferentially overlaps top quadrant of pipe. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.
2. Lower wrapped pipe into trench and make up pipe joint with preceding section of pipe. Make shallow bell hole at joints to facilitate installation of polyethylene. After completing joint, make overlap and secure ends.
3. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

E Pipe-shaped Appurtenances: Cover bends, reducers, offsets, and other pipe-shaped appurtenances with polyethylene in same manner as pipe.

F Odd-shaped Appurtenances: When it is not practical to wrap valves, tees, crosses, and other odd-shaped pieces in tube, wrap with flat sheet or split length of polyethylene tube by passing sheet under appurtenance and bringing it up around body. Make seams by bringing edges together, folding over twice, and taping down. Tape polyethylene securely in place at valve stem and other penetrations.

G Repairs: Repair any cuts, tears, punctures, or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around pipe to cover damaged area, and secured in place.

H Openings in Encasement: Provide openings for branches, service taps, blowoffs, air valves, and similar appurtenances by making an X-shaped cut in polyethylene and temporarily folding back film. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene, with tape. Service taps may also be made directly through polyethylene, with any resulting damaged areas being repaired as described above.

I Junctions between Wrapped and Unwrapped Pipe: Where polyethylene-wrapped pipe joins an adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for distance of at least 3 feet. Secure end with circumferential turns of tape. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for minimum clear distance of 3 feet away from cast or ductile iron pipe.

END OF SECTION

Section 02513

STEEL PIPE AND FITTINGS FOR LARGE DIAMETER WATER MAINS

1.0 GENERAL

1.01 SECTION INCLUDES

A. New large diameter (24 inches and greater) steel pipe and fittings for water mains and pumping facilities.

B. References to Technical Specifications:

1. Section 01350 – Submittals
2. Section 01450 – Testing Laboratory Services
3. Section 02510 – Water Mains

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM A36 - Standard Specification for Structural Steel
b. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped - Zinc-Coated Welded and Seamless.
c. ASTM A135, Standard Specification for Electric-Resistance-Welded Steel Pipe.
d. ASTM A139 - "Standard Specification for Electric-Fusion (ARC) - Welded Steel Pipe (NPS 4 and Over)"
e. ASTM A570 - Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
f. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High Strength Low-Alloy, High-Strength Low Alloy with Improved Formability and Ultra-High Strength.
g. ASTM A1018 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commerical, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability and Ultra-High Strength.
h. ASTM C33 - Standard Specification for Concrete Aggregates.
i. ASTM C35 - Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.
j. ASTM C150 - Standard Specification for Portland Cement.
k. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
l. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
m. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

n. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
o. ASTM D512 - Standard Test Methods for Chloride Ion in Water.
p. ASTM D1293 - Standard Test Methods for pH of Water.
q. ASTM D3363 - Standard Test Method for Film Hardness by Pencil Test.
r. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Tests.
s. ASTM D4752 - Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub.

2. American Water Works Association (AWWA)

a. AWWA C200 - Steel Water Pipe 6 inches and Larger
b. AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe.
c. AWWA C206 - Standard for Field Welding of Steel Water Pipe.
d. AWWA C207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inch Through 144 inch
e. AWWA C208 Dimensions for Fabricated Steel Water Pipe Fittings; Addendum C 208A.
f. AWWA C209 - Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
g. AWWA C210 - Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
h. AWWA C214 - Tape Coating Systems for the Exterior of Steel Water Pipelines.
i. AWWA C216 - Heat-Shrinkable Cross-Linked Polyoefin Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
j. AWWA C602 - Cement-Mortar Lining of Water Pipelines - 4 inch (100 mm) and Larger - In Place.
k. AWWA M11 - Steel Pipe - A Guide for Design and Installation.

3. American National Standards Institute (ANSI)
a. NSF Standard 61

4. National Sanitation Foundation (NFS)

5. Society of Protective Coatings (SSPC)

a. SSPC Good Painting Practice, Volume 1.
b. SSPC SP 1 - Surface Preparation Specification No. 1 Solvent Cleaning.
c. SSPC SP 5 - Joint Surface Preparation Standard White Blast Cleaning.
d. SSPC SP 6 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.

e. SSPC SP 10 - Surface Preparation Specification No. 10 Near-White Blast Cleaning.
f. SSPC VIS 1 - Visual Standard for Abrasive Blast Cleaned Steel.

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for steel pipe and fittings under this Section. Include cost in Bid Items for water mains.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit Shop Drawings signed and sealed by Professional Engineer registered in State of Texas showing following:

1. Manufacturer's pipe design calculations.

2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Engineer. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*.PDF).

3. Include hot tapping procedure.

4. Submit certification from manufacturer that design was performed for project in accordance with requirements of this Section. Certification to be signed and sealed by Professional Engineer registered in State of Texas.

C. Submit manufacturer's certifications that pipe has been hydrostatically tested at factory in accordance with AWWA C200.

D. Submit certification from NACE Certified Coatings Inspector, under supervision of inspector having Level III certification for coatings and linings, that steel pipe furnished on project was properly inspected and defective coatings detected properly repaired.

E. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit at least 30 days prior to repair work, procedures that describe in details shop and field work to be performed. Repair defects

such as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, etc.

F. Submit following for nonshrink grout for special applications:

1. Manufacturer's technical literature including specifications for mixing, placing and curing grout.

2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C1107, Nonshrink Grout and requirements of this specification.

G. Submit proof of certification for welders. Indicate certified procedures and position each welder is qualified to perform. Ensure welder and welding operator have been certified in accordance with AWWA C206.

H. Within 45 calendar days after manufacturing of all pipe, submit affidavit of compliance that materials and work furnished comply with applicable requirements of referenced standards and these specifications. Make available copy of physical and chemical testing reports.

I. Within 45 days of manufacturing of all pipe, submit manufacturer's affidavits that coatings and linings comply with applicable requirements of this Section and:

1. Polyurethane coatings were applied in accordance with manufacturer's recommendation and allowed to cure at temperature 5 degrees above dew point.

2. Mortar coatings and linings were applied and allowed to cure at temperature above 32 degrees F.

3. Test Results
   a. Compressive strength (7 and 28 day) test results for mortar coating.
   b. Hydrostatic testing, magnetic particle and x-ray weld test reports as required.

J. Prior to start of field-applied cement mortar lining operation, submit comprehensive plan which identifies and describes as minimum:

1. Equipment used for batching, weighing, mixing, transporting and placing mortar.

2. Qualifications and specific experience of machine operators.

3. Source and type of cement, pozzolan, sand and admixtures used and certifications from suppliers that materials meet specifications.
4. Mix proportions to be used and slump limits (max. and min.)

5. A quality control plan which identifies quality control material tests and documented inspections necessary to ensure compliance with specified requirements.

K. Submit certification showing calibration within last 12 months for equipment such as scales, measuring devices, and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by Engineer.

1.04 QUALITY CONTROL

A. Manufacturer to provide permanent quality control department and laboratory facility capable of performing inspections and testing as required by specifications. Material testing, inspection procedures and manufacturing process are subject to inspection by Engineer. Perform manufacturer's tests and inspections required by referenced standards and these specifications, including the following. Correct nonconforming conditions.

1. Steel Plate and Coils:
   a. Review mill certifications for conformance to requirements of specifications; perform physical and chemical testing of each heat of steel for conformance to applicable ASTM standards.

2. Pipe:
   a. Inspect thickness, circumference, roundness, strength and size of seam welds (spiral or longitudinal), and squareness of pipe ends to verify compliance with AWW C200.

   b. Inspect physical dimensions and overall conditions of all joints for compliance with AWWA C200, approved submittals and specifications.

   c. Hydrostatically test finished pipe section to 75 percent of specified minimum yield strength of steel being used with zero leakage.

   d. For wall thickness greater than 1/2-inch perform Charpy V-Notch (CVN) Test in accordance with AWWA C200.

3. Linings:
   a. Inspect unlined pipe for overall condition of inside barrel. Maintain inside barrel free of corrosive products, oil, grease, dirt, chemical and deleterious material.

b. Inspect lined pipe for physical dimensions and overall condition of lining, visible surface defects, thickness of lining and adhesion to steel surface.

c. Review certifications by manufacturers of lining components for conformance to AWWA standards and these specifications.

4. Coatings:
   a. Measure temperature and dew point of ambient air before applying coatings.

   b. Inspect physical dimensions and overall condition of coatings.

   c. Inspect for visible surface defects, thickness, and adhesion of coating to surface and between layers.

5. Final Inspection:
   a. Before shipment, inspect finished pipe, fittings, specials and accessories for markings, metal, coating thickness, lining thickness (if shop applied), joint dimensions and roundness.

   b. Inspect for coating placement and defects. Test exterior coating for holidays.

   c. Inspect linings for thickness, pitting, scarring and adhesion.

B. Shop-applied coatings and linings; provide services of independent coating and lining inspection service or testing laboratory with qualified coating inspectors. Perform inspection by NACE trained inspectors under supervision of NACE Level III Certified Coatings Inspector.

C. Ensure workmen engaged in manufacturing are qualified and experienced in performance of their specific duties.

D. Cast four standard test cylinders each day for each 50-cubic yards of mortar coating or portion thereof for each coating and lining placed in a day. Perform compressive strength test at 28 days. No cylinder test result will be less than 80 percent of specified strength.

E. Dented steel cylinders will result in rejection of pipe.

F. Make available copy of physical and chemical testing reports for steel cylinders and provide reports at request of Engineer.

G. Check physical dimensions of pipe and fittings. Physical dimensions to include at least pipe lengths, pipe I.D., pipe O.D. and bend angles.

H. Test special sections via non-destructive testing methods in accordance with AWWA C200. Acceptable weld test methods include magnetic particle, liquid penetrant, ultrasonic and radiographic.

1.05 INSPECTION

A. Engineer may witness manufacture and fabrication of pipe and appurtenances. Independent testing laboratory under contract to Engineer may perform tests at direction of Engineer to verify compliance with these specifications. Provide assistance to accomplish such testing, including equipment and personnel at no additional cost to City.

2.0 PRODUCTS

2.01 STEEL PIPE

A. Furnish pipe by same manufacturer.

B. Furnish pipe smaller than 24 inch in accordance with Section 2635 - Steel Pipe and Fittings.

C. Fabricate and supply miscellaneous steel pipe and fittings with nominal diameter of 24 inches and larger in accordance with AWWA C200, C207, C208 AND AWWA M11 except as modified herein. Steel to be minimum of ASTM A36, ASTM A570 Grade 36, ASTM A53 Grade B, ASTM A135 Grade B, ASTM A139 Grade B, ASTM A1011 Grade 36 or ASTM A1018 Grade 36.

D. Provide pipe sections in lengths no greater than 40 feet and no less than 10 feet except as required for special fittings or closure sections.

E. Provide shop-coated and shop-lined steel pipe with minimum of one coat of shop-applied primer approved for use in potable water transmission on all exposed steel surfaces. Primer for tape-coated steel pipe to be used for field-applied coatings shall have no less than 5 percent solids. Provide primer compatible with coating system and in accordance with coating manufacturer's recommendations.

F. Provide closure sections and short sections of steel pipe not less than 4 feet in length unless indicated on Drawings or specifically permitted by Engineer.

G. Square flanges with pipe with bolt holes straddling both horizontal and vertical axis. Provide 1/2-inch gap between pipe ends to be coupled with sleeve coupling unless otherwise indicated on Drawings

1. Provide standard ring or hub type flanges, conforming to AWWA C207, Class D.

2. Apply Densco petroleum-based tape or approved equal to exposed portions of nuts and bolts.

H. Pipe Design Conditions:

1. Design:
   a. Design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures.

   b. Base design on minimum of AASHTO HS-20 loading, AREMA E-80 loads and depths of bury as indicated on Drawings.

   c. Design pipes with Marston's earth loads for transition width trench for all heights of cover.

2. Groundwater Level: Design for most critical ground water level condition.

3. Working pressure = 100 psi.

4. Hydrostatic field test pressure = 150 psi.

5. Maximum pressure due to surge = 150 psi.

6. Minimum pressure due to surge = -10 psi.

7. Modulus of elasticity (E) = 30,000,000 psi.

8. Maximum deflection from specified diameter: Two percent for mortar coating; three percent for flexible coatings and three percent for mortar lining.

9. Design stress due to working pressure to be no greater than 50 percent of minimum yield and stress not to exceed 16,500 psi for mortar coated pipe.

10. Design stress due to maximum hydraulic surge pressure to be no greater than 75 percent of minimum yield, and stress not to exceed 24,750 psi for mortar coated pipe, or 31,500 psi for flexible coated pipe.

11. Modulus of soil reaction (EN) < 1,500 psi. If EN > 1,000 psi, do not use silty sand (SM) for embedment.

12. Unit weight of fill (w) > 120 pcf.

13. Deflection lag factor (D1) = 1.2.

14. Bedding constant (K) = 0.1.

15. Fully saturated soil conditions: hw = h = depth of cover above top of pipe.

16. Do not allow diameter (D) over thickness (t) ratio to be greater than 230.

17. Provide minimum inside clear diameter for tunnel liners or casing in accordance with Section 02425 LD - Tunnel Excavation and Primary Liner.

18. Exclude structural benefits associated with primary liner in design of pipe in tunnel installations.

    a. Design pipe and joints to carry loads including overburden and lateral earth pressures, subsurface soil and water loads, grouting, other conditions of service, thrust of jacks, and stresses anticipated during handling and construction loads during installation of pipe.

    b. Do not use internal removable stiffeners for pipe in tunnel, unless approved by Engineer.

    c. External welded steel stiffeners will be permitted in design calculations for steel pipe, provided wall thickness is minimum of 1/2 inch. Minimum clearances specified between exterior pipe wall and tunnel liner applies to distance between outside diameter of external welded stiffener and tunnel liner.

19. Nominal Allowable Steel-wall Thickness for Water Lines:

    a. Provide in accordance with following table for HS-20 live loads and depths of cover of up to 16 feet.

    b. Net internal diameter (including inside linings) to be no less than net inside diameter listed.

    c. Contractor to review design for conditions more extreme than those indicated by this specification and design accordingly.

    d. If, in opinion of Engineer, proposed pipe wall thicknesses appear inadequate for indicated loading conditions, submittal of design calculations will be required for review.

    e. Pipe wall not to be less than that defined in following table:

Net Inside Diameter (Inches)	**Minimum Wall Thickness (Inches)**	
	Flexible Coating	**Mortar Coating**
96	0.484	0.464
90	0.454	0.430

84	0.423	0.395
78	0.393	0.359
72	0.362	0.320
66	0.333	0.295
60	0.301	0.268
Net Inside Diameter (Inches)	**Minimum Wall Thickness (Inches)**	
	Flexible Coating	**Mortar Coating**
54	0.271	0.250
48	0.235	0.215
42	0.207	0.189
36	0.178	0.163
30	0.149	0.136
24	0.149	0.136

I. Fittings for Water Lines: Fabricate in accordance with AWWA M11, Section 13.3-13.7 and AWWA C208.

1. Wall Thickness: Equal to or greater than pipe to which fitting is to be welded.

2. Elbows: 2-piece for 0 degrees to 22-1/2 degrees; 3-piece for 23 degrees to 45 degrees; 4-piece for 46 degrees to 67-1/2 degrees; and 5-piece for 68 degrees to 90 degrees, unless otherwise shown on Drawings.

3. Outlets: Reinforced in accordance with AWWA M11, Sections 13.3-13.7, AWWA C200, and AWWA C208. Provide interior lining and exterior coating in accordance with paragraphs on coating and lining and matching pipe to access inlets, service outlets, test inlets, and air-vacuum valve and other outlets, including riser pipes.

4. Radius: Minimum radius of two and one-half times pipe diameter.

5. Butt Straps for Closure Piece: Minimum 12-inch-wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Provide minimum lap of 4 inches between member being joined and edge of butt strap, welded on both inside and outside, unless otherwise approved by Engineer. Provide minimum 6-inch welded outlet for inspecting each closure section, unless access manway is within 40 feet of closure section.

6. Joints are to be double-welded and butt or lap joints. Use flanged joints at valves.

7. Provide double-welded lap field joints or full penetration butt-welded joints for tee fitting supported on pier foundation, aboveground piping and field welds

for risers including vertical portion of crossover piping.

J. Joints:

1. Standard field joint for steel pipe: AWWA C206. Rubber gasket Carnegie shape joint or rolled-groove rubber gasket and O-ring joint, 66-inch maximum diameter. Joints may be lap-welded slip type in accordance with AWWA C206, except where flanged joints or butt strap joints are required.

2. Provide double-welded butt joints at aerial crossings and where noted on Drawings.

3. Pipe Manufacturer: Minimum of 5 years of successful service with proposed field joint or submit results from joint tests determined by Engineer. Tests which may be required include tensile strength or yield tests of base material and spiral welded sections (API 5L), flattening tests, chemical analysis, impact and hardness tests. Engineer's decision as to acceptability of joint is final.

4. Capable of withstanding jacking forces.

5. Design restrained joints for test pressure or maximum surge pressure as specified, whichever is greater. Only minimum restrained joint lengths for prestressed concrete cylinder pipe are shown on Drawings.

6. Provide full circumferential welds at joints required to be welded.

7. Use wire and flux from same manufacturer throughout entire project.

8. Rubber Gasketed Bell-and-Spigot Joints.

   a. Bells: Formed by either expansion of pipe end, or by segmental expander which stretches steel past its elastic limit, or by attaching sized weld-on bell rings. Weld-on bell rings shall comply with AWWA M11 and AWWA C200, attached with full-thickness fillet welds, and welded inside and out (double welded). Minimum thickness of completed bell ring is equal to or greater than thickness of pipe wall in barrel of pipe between joint ends.

   b. Spigots: Sized prior to rolling gasket groove. For Carnegie joints, attach with full thickness fillet welds, welded inside and out (double welded). Minimum thickness of joint ring shall be equal to or greater than thickness of pipe wall in barrel of pipe between joint ends.

   c. Joints shall be interchangeable and match up during installation, even if used out of sequence.

d. Provide bells and spigots with dimensions and tolerances in accordance with AWWA C200, as modified herein. Difference in diameter between I.D. of bell and O.D. of spigot shall be between 0.00 inch to 0.10 inch as measured with steel circumference tape. Measurement shall be taken at point of full joint engagement, and pipe cylinder shall be within allowable deflection. Clearance between bell and spigots shall be such that, when joint is assembled, water-tightness will be obtained under operating conditions.

e. Furnish joint suitable for safe working pressure equal to class of pipe. Joint shall operate satisfactorily with pull-out, tangent of which is not to exceed 0.75inch/D where D is outside diameter of pipe in inches or with pull-out of 3/4 inch.

f. Joints shall be self-centered and gasket will be restrained or confined to annular space in such manner that movement of pipe or hydrostatic pressure cannot displace it. Compression of gasket when joint is completed shall provide watertight joints under operating conditions when properly installed. Compression of gasket shall not be dependent upon water pressure in pipe.

K. Manufacturer must maintain on site or in plant enough fittings to satisfy the following requirements:

Line Diameter	Required Bends*
20 and 24 inches	Four 45 degree bends per 5,000 LF of water line
> 24 inches	Four 22.5 degree bends per 10,000 LF of water line
*Based on total length of contract (minimum of four). Any combination of bends may be substituted at manufacturer's option (i.e. two 22.5 degree bends are equivalent to one 45 degree bend) and will be counted as one fitting.	

L. Manufacturer must be capable of delivering bends to job site within 12 hours of notification. Use fittings at direction of Engineer where unforeseen obstacles are encountered during construction. These fittings are in addition to fittings called out on Drawings and must be available at all times. Use same product throughout entire project.

M. Hydrostatic Test of Pipe:

1. AWWA C200, Section 5.2, at point of manufacture. Hold test for minimum 2 minutes and conduct thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.

2. Calibrate pressure gauges within one year prior to testing as specified in Section 1.04 L.

N. Provide forged steel threaded outlets of approved design where required for use in passing hose or lead wires into pipe. Tap plugs with standard pipe threads and weld to pipe in approved manner and use solid forged steel plugs for closure.

O. Flanges:

1. Fabricate flanges with oversize bolt holes, with flanges drilled in pairs, to accommodate insulating sleeves.

2. Test, coat, line and ship each shop-assembled insulated flange assembly to field as fitting. Use no less than two snug-fitting alignment pins to assist in aligning flanges during assembly. Do not remove pins until bolts have been installed in all remaining holes and have been drawn up tight. After insulating joints have been assembled, subject each assembly (fitting) to shop hydrostatic test pressure of 150 psi and electrically test to ensure that insulated sections are effective. After assembly has been tested, coat insulating joint and adjacent steel pipe as specified for below-ground installation. Line assembly as specified for interior surfaces and in accordance with details shown on Drawings.

P. Dished Head Plugs: Design dished head plugs (test plugs) to withstand field hydrostatic test pressure from either side of plug. Design stress due to hydrostatic pressure to be no greater than 50 percent of minimum yield. Pipe on opposite side of hydrostatic test may or may not contain water. Manufacturer of the steel pipe to hydrostatically test plug at factory.

Q. Make curves and bends by deflecting joints, or by using beveled joints, or by combination of two methods, unless otherwise indicated on Drawings or permitted by Engineer. Do not exceed deflection angle at joint as recommended by pipe manufacturer. Make penetration of spigot into bell at all points of circumference at least equal to minimum required penetration shown on Drawings. Beveled pipe sections used in curved alignment to be of standard length except when shorter sections are required to limit radius of curvature, in which case all sections throughout curve are to be of equal length. Do not allow bevel to exceed 5 degrees.

2.02 INTERNAL LINING SYSTEMS FOR STEEL PIPE, ALL INSTALLATIONS

A. Supply steel pipe with either epoxy lining or cement-mortar lining, capable of conveying water at temperatures not greater than 140 degrees F. Provide linings conforming to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61, and certification to be from organization accredited by ANSI. Unless otherwise noted, coat all exposed (wetted) steel parts of flanges, blind flanges, bolts, access manhole covers, with epoxy lining, as specified.

B. Epoxy Lining:

1. AWWA C210, color White, or approved equal for shop and field joint applied, except as modified in this Section. Provide materials from same manufacturer.

   a. Protect interior surface with approved liquid two-part chemically cured epoxy primer specified for interior surfaces

Surface Preparation	**SSPC-SP5 White Blast Clean 2.0 to 3.0 mils surface profile.**
Prime Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy - Buff, or approved equal
Intermediate Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy - Buff, or approved equal
Finish Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy - White, or approved equal

2. Total allowable dry film thickness for system:

   a. Minimum: 12.0 mils.
   b. Maximum: 18.0 mils.

3. Provide dry film thicknesses for approved alternate products in accordance with product's manufacturer recommendations.

4. Lining system may consist of three or more coats of same approved alternate epoxy lining without use of separate primer.

5. Perform adhesion test on pipe 48 inches in diameter and larger in accordance with ASTM D4541. Minimum field adhesion: 700 psi. Perform test on pipe for project at frequency of one for every 1000 square feet of epoxy lining. Perform cure test in accordance with ASTM D4752 (solvent rub test) and ASTM D3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

C. Shop-applied Cement-mortar Lining:

1. AWWA C205; except as specified herein: 1/2-inch minimum thickness for pipe diameters 42 inches and larger; 3/8-inch minimum thickness for pipe diameters 36 inches and smaller. Cut back lining from joint ends no more than 2 inches to facilitate joining and welding of pipe.

2. Apply cement-mortar lining to inside of pipe by centrifugally spinning. For special sections (shape of which precludes application by spinning method) accomplish by mechanical placement or pneumatic placement and finish to produce smooth, dense surface comparable to centrifugally spinning.

3. Use galvanized wire mesh when shop-applied mortar is not applied by machine. Do not extend wire mesh across welded portion of mitered fittings. Crimp mesh to provide integral "chair" so wire does not fully rest against steel cylinder.

4. Make repairs of cement-mortar lining for widths exceeding 6 inches by bonding to steel and adjacent faces of lining with bonding agent conforming to ASTM C881, Type II.

5. Restrict usage of sprinkler heads during moist curing to prevent over spraying onto lining. No alternative curing methods are allowed as described in Section 4.4.7.4 of AWWA C205.

6. Satisfy Engineer that above requirements can be accomplished by manufacturer prior to shipment of pipe.

D. Field-Applied Cement-Mortar Lining (for pipe > 48 inches in diameter): Provide field-applied internal cement-mortar linings in accordance with AWWA C602, latest edition, except as modified in this Section.

1. Lining: Applied in one-course application of cement-mortar by machine that centrifugally places mortar against wall of pipe and mechanically trowel lining to smooth finish.

2. Steel pipe, fittings, receives cement-mortar lining.

3. Cement-mortar for lining.

a. Cement-mortar: Dense, smooth, and of uniform quality and consistency to assure efficient machine operation and uniform cement-mortar lining on pipe wall.

b. Water-cement ratio: Kept as low as possible; consistent with proper plasticity for application, allowing slight variations dependent upon temperature, length of haul for mortar, and moisture condition in pipe.

c. Mortar: Mixture of one part cement with not less than one or more than 1-1/2 parts of dry screened sand, by volume. After determining mixture, control materials to within plus or minus 2-1/2 percent by weight throughout entire work.

d. Comply with following materials for cement-mortar:

1) Provide Type II low-alkali Portland cement conforming to ASTM C150, or Type IP (MS) Portland-Pozzolan cement

conforming to ASTM C595, unless otherwise specified. Conform to low alkali requirements of Table IA of ASTM C150. Type IP (MS) cement to contain no more than 20 percent Pozzolan, to be inter-ground with clinker.

2) Use suitable facilities approved by Engineer when available for handling and weighing bulk cement. Otherwise, deliver cement in original unopened sacks that have been filled by manufacturer. Plainly mark sacks with manufacturer's name or brand, cement type lot number and weight. Discard unused cement. Use unopened bags of cement for each new batch.

3) Material storage: Store cement to permit ready access for inspection and sampling. Protect cement and sand against contamination or moisture. Do not use and remove from site cement delivered with evidence of contamination or otherwise unsuitable. Store admixtures in accordance with manufacturer's directions.

4) Use Portland cement of same brand and type unless otherwise approved by Engineer.

5) Pozzolanic material: AWWA C602, Paragraph 2.2.

6) Sand: AWWA C205, Section 2.3, except gradation of sand to yield fineness modulus of approximately 1.7; having no material coarser than that passing No. 16 sieve. Submit certification for compliance of sand with these specifications at least 10 calendar days before start of lining placement.

7) Water: Clean; free of deleterious amounts of acids, alkalis or organic materials; total dissolved solids less than 1000 mg/l; ASTM D512 chloride ions less than 100 mg/l for slurry and mortar cure; ASTM D1293 pH greater than 6.5.

2.03 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVEGROUND AND IN VAULTS (EXPOSED)

A. Provide approved 3-coat epoxy/polyurethane coating system as designated below. Provide materials from same manufacturer.

Surface Preparation	**SSPC SP10 Near White Blast Clean 2.0 to 3.0 mils surface profile**
Prime Coat 4.0 to 4.0 mils DFT	Inhibitive Epoxy Primer, or approved equal
Intermediate Coat 4.0 to 6.0 mils DFT	Chemical Resistant Epoxy, or approved equal
Finish Coat 1.5 to 2.5 mils DFT	Polyurethane, or approved equal Blue Fed. Std. No. 15102 color as approved by Engineer

B. Total Allowable Dry Film Thickness for System:

1. Minimum: 9.5 mils.
2. Maximum: 12.5 mils.

C. Perform adhesion test on pipe 48 inches in diameter and larger in accordance with ASTM D4541. Minimum field adhesion: 700 psi. Perform test on pipe for project at frequency of one for every 1000 square feet of epoxy lining. Perform cure test in accordance with ASTM D4752 (solvent rub test) and ASTM D3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

2.04 EXTERNAL COATING SYSTEMS FOR BURIED STEEL PIPE

A. Supply pipe with one of the following coatings specified.

1. Tape Coating: Provide approved tape for external tape coating. Apply in accordance with AWWA C 214 and requirements of this section; 80 mil.

a. Components: Primer, one 20-mil layer of inner-layer tape for corrosion protection and two 30-mil layers of outer-layer tape for mechanical protection.

b. Where sleeve type or victaulic couplings are required, bond coupling to adjacent pipes with bonding cables as shown on Drawings.

c. Use approved filler putty type insulating putty to fill in gap and create smooth, sloped transition between top of reinforcing plate and pipe, before tape coating is applied.

d. Primer: Compatible with tape coating, supplied by coating-system manufacturer.

e. Provide pipe with shop coatings cut back approximately 4 to 4-1/2 inches from joint ends to facilitate joining and welding of pipe. Taper

successive tape layers by 1-inch staggers to facilitate field wrapping and welding of joints.

f. Inner and outer tape width: 12 or 18 inches.

g. Do not expose tape coating to direct sunlight for more than 60 days.

2. Cement-mortar Coating: AWWA C 205; shop-applied, cement-mortar coating except as modified in this Section; 1-inch minimum thickness; cut back coating from joint ends no more than 2 inches to facilitate joining and welding of pipe.

3. Polyurethane Coating: See Section 02636 - Polyurethane Coatings on Steel or Ductile Iron Pipe for requirements for use of polyurethane coating system. Refer to Paragraph 2.03 C of this Section for field testing requirements. Provide inspections by NACE trained inspectors under supervision of NACE Certified Coatings Inspector having Level III Certification.

B. Heat Shrink Joint Sleeves for Tape and Polyethane Coating: Aqua-shield, or approved equal. For repairs to heat shrink joint sleeves, use Aqua-shield Repair Kit or approved equal. Pipe manufacturer to hold back coatings at joints as per shrink sleeve manufacturer's recommendations.

2.05 EXTERNAL COATING SYSTEM FOR STEEL PIPE IN TUNNEL, CASING

A. Provide exterior coating system of pipe in tunnel, without annular grout, as specified in Cement Mortar Coating for Buried Steel Pipe, or provide minimum 80 mils of polyurethane coating in accordance with Specification Section 02636 - Polyurethane Coatings for Steel or Ductile Iron Pipe.

B. For water lines in tunnel where annular grout will be used, shop prime external surfaces of steel pipe with 4.0 to 6.0 mils DFT of approved Inhibited Epoxy Primer unless pipe has cement-mortar coating.

1. Surface Preparation:
   a. SSPC-SP 10(64).
   b. Near White Blast Clean 2.0 to 3.0 mils surface profile.

2. Prime Coat:
   a. Approved Inhibitive Epoxy Primer 4.0 to 6.0 mils DFT.

3. Use coating procedures and dry film thicknesses for approved alternate product in accordance with product manufacturer's recommendations.

2.06 GROUT FOR JOINTS AND SPECIAL APPLICATIONS

A. Cement Grout Mixture: One part cement to two parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream. Mix cement grout to specific gravity of 19 lb/gallon or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of Engineer. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.

1. Portland Cement:
   a. ASTM C 150, Type II.
   b. Provide one type of cement for entire project.

2. Sand:
   a. Interior joints: ASTM C 35 fine graded plaster sand.
   b. Exterior joints: ASTM C 33; natural sand with 100 percent passing No.16 sieve.

3. Water:
   a. Potable water with total dissolved solids less than 1000 mg/l.
   b. ASTM D 512 chloride ions less than 100 mg/l for slurry and mortar cure.
   c. ASTM D 1293 pH greater than 6.5.
   d. Use potable water with 250 ppm limit on chlorides and sulfates.

B. Provide approved Nonshrink Grout for Special Applications, Patches and Repairs.

1. Conform to requirements of ASTM C 1107, Nonshrink Grout.

2. Pre-blended factory-packaged material manufactured under rigid quality control, suitable for use in joints of prestressed concrete cylinder pipe.

3. Contain non-metallic natural aggregate and be nonstaining and noncorrosive.

4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.

5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.

6. Compressive strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.

7. Non-bleeding and non-segregating at fluid consistency.

8. Contain no chlorides or additives which may contribute to corrosion of steel pipe.

9. Free of gas-producing, gas-releasing agents.

10. Resist attack by oil or water.

11. Mix, place, and cure in accordance with manufacturer's instructions and recommendations. Upon 72 hours' notice, provide services of qualified representative of nonshrink grout manufacturer to aid in assuring proper use of product under job conditions. Representative to be on site when product is first used.

12. Mix cement grout to specific gravity of 17.7 lb/gallon or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of Engineer. Add additional cement grout to mixed cement grout or water to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.

13. Compressive strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.

C. Finished surface of lining and interior joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

D. Joint Wrapper: Minimum width of 9 inches for 33-inch diameter and smaller; minimum width of 12 inches for diameters greater than 33-inch hemmed at edge to allow threading with minimum 5/8-inch-wide steel strap. Provide minimum 6-inch wide Ethafoam strip sized, positioned, and sewn such that two circumferential edges of Ethafoam are 1-1/2 inches from outer edge of wrapper.

2.07 COLD-APPLIED TAPE COATING

A. Shop-applied Tape Wrap Coating

1. Use primer furnished by tape manufacturer.

2. Wrap, specials and fittings that cannot be machine wrapped due to configuration with primer layer and two layers of prefabricated tape each 35 mils thick.

3. Overlap machine applied tape with hand applied tape by minimum of two

inches and bind to it.

4. Apply approved 30 mil filler tape parallel to spiral weld seams if weld height measures greater than or equal to 1/8 inch.

B. Surface Preparation

1. Clean bare pipe from mud, mill lacquer, oil, grease, or other contaminants. Inspect and clean surfaces according to SSPC-SP-1 to remove oil, grease, and loosely adhering deposits prior to blast cleaning. Remove visible oil and grease spots by solvent wiping. Use approved safety solvents which do not leave residue. Preheating to remove oil, grease, mill scale, water, and ice may be used provided pipe is preheated in uniform manner to avoid distortion.

2. Remove surface imperfections such as slivers, scabs, burrs, weld spatter, and gouges by hand filling or grinding to prevent excessive number of holidays. Presence of metallic defects may be cause for rejection of pipe.

2.08 EXTERNAL TAPE COATING SHOP APPLICATION

A. Separate tape dispensing equipment far enough apart to visually inspect continuous steps.

B. Make cutbacks straight and for total thickness of coating.

C. State of dryness of primer prior to application of weld filler and inner layer of tape to be in accordance with written recommendation of manufacturer.

D. Apply weld filler tape over primer and extend minimum of one inch on each side of weld seam. Filler tape may contact rollers as long as release liner is in place and adhesion requirements are met. Remove release liner before applying inner layer tape.

E. Spirally apply inner layer of tape in direction of helix weld. Overlap each spiral of tape1 inch or greater with next successive spiral of tape applied.

F. Overlap end of new roll on top of previous roll minimum of 6 inches.

G. Tape-roll body temperature to be greater than 70 degrees F; pipe surface temperature to be greater than 60 degrees F.

H. Spirally apply outer layer tapes in direction of helix weld and use overlap width and application tensions as recommended by manufacturer.

2.09 INSPECTION AND TESTING OF COATINGS

A. Perform electrical inspection on inner layer of tape before intermediate layer of tape is applied.

B. If holidays are detected, repair holidays immediately before applying outer layer of tape. Clear holiday area of material and reprime if necessary. Recoat area with inner wrap tape. Overlap inner wrap tape onto surrounding inner wrap coating by at least 2 inches. Perform electrical retest at repaired area after repairing holiday, and before outer wrap is continued.

C. Shrink Wrap: Perform electrical inspection on shrink wrap to check for holidays. Perform peel tests over heat affected zone. Minimum acceptable result: 15 lbs-ft/in.

3.0 EXECUTION

3.01 PIPING INSTALLATION

A. Conform to applicable provisions of Section 02510 – Water Mains except as modified in this Section.

B. Comply with following:

1. Make available services of manufacturer's representative when deemed necessary by Engineer. Representative to advise in aspects of installation, including but not limited to handling and storing, cleaning and inspecting, coating and lining repair, and general construction methods as applicable to pipe.

2. Install stulls prior to placement of pipe, bends, and fittings to prevent deflection during installation. Provide stulls consisting of timber struts with end blocks shaped to fit curvature of interior surface of pipe or other appropriate configuration and material. Firmly edge and secure stulls to blocks so that they will remain intact position during handling and installation. Provide stulls adequate to resist loads encountered without structural failure to stull members or damage to pipe. Where applicable, place stulls at such lengths so as to elongate vertical diameter of pipe as required to suit trench conditions encountered.

3. Handling and Storage: Install padded struts or stulls prior to shipping, horizontally and vertically at 10-foot intervals, or as proposed by manufacturer and approved by engineer. Spiders: Installed in joint ends of fittings. Stulls to remain in place, horizontally and vertically positioned under following conditions:

a. During storage and shipping.

b. Until welding is complete.

4. Reject and remove immediately from site pipe that arrives at site with defects in lining, including sand pockets, voids, and oversanded areas.

5. Store pipe at job site with securely fastened plastic endcaps to maintain moist pipe interior. Promptly replace damaged endcaps to avoid shrinkage or cracking of cement-mortar lining.

6. Immediately replace damaged plastic end caps. Do not leave uncapped for more than 4 hours.

7. Bedding and Backfilling:

   a. Conform to requirements of Section 02318 - Excavation and Backfill for Utilities.

   b. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.

   c. Take necessary precautions during bedding and backfilling operations to prevent deformation or deflection of cylindrical shape of pipe by more than allowable pipe deflection. Do not move trench support system (trench safety system) once bedding material is compacted.

   d. Excavate outside specified trench section for bell holes, and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell holes as required or directed by Engineer. Subsequent backfilling thereof will not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of Engineer.

   e. Blocking may be removed 24 hours after placing backfill to top of pavement or natural ground level.

8. Pipe Deflection: After backfill is complete, test pipe for excessive deflection by measuring actual inside vertical diameter. For maximum deflection allowable, see Section 2.01.

   a. Deflection may be measured by Engineer at location along pipe. Arithmetical averages of deflection are not acceptable.

   b. If deflection exceeds that specified, do one of the following:

1) Remove backfill and side support. Reround the pipe and properly replace compacted backfill and side support. Review cement mortar lining to assure that no harmful damage has occurred.

2) Remove entire portion of deflected pipe section and install new pipe as directed by Engineer at no additional cost to City.

9. Move pipe in such manner not to damage pipe or coating. Do not roll pipe nor drag on ground. Inspect and repair coating abrasions before pipe is lowered into trench.

10. Use of dogs, clips, lugs, or equivalent devices welded to steel pipe for purpose of forcing it into position will not be permitted unless approved by Engineer. Remove foreign matter and protective material from surfaces that are to be in contact at joints. Leave surfaces of joint areas thoroughly clean for metal-to-metal contact of field joints.

C. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.

2. Electrically test where required after installation of pipeline is complete.

D. Deviation of installed pipe in one pipe section from line and grade shown on approved shop drawing layout will not exceed 2 inches from grade and 3 inches from line. No deviation from line and grade at contact interfaces are allowed.

E. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by Engineer and submit copy of data to Engineer at end of that day. Survey data to include unique pipe number, deflection angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom, and at springline (each side).

F. Any time that laying of additional pipe is stopped for more than eight hours; plug ends of installed pipe and take proper precautions against flotation of pipe segments.

3.02 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVE GROUND AND IN VAULTS (EXPOSED) AND EPOXY INTERNAL LINING SYSTEM

A. Safety: Paints, coatings, and linings specified in this Section are hazardous materials. Vapors may be toxic or explosive. Protective equipment, approved by appropriate regulatory agency, is mandatory for personnel involved in painting, coating, and lining operations.

B. Workmanship:

1. Application: By qualified and experienced workers who are knowledgeable in surface preparation and application of high-performance industrial coatings.

2. Paint Application Procedures: SSPC Good Painting Practices, Volume 1.

C. Surface Preparation:

1. Use abrasive blasting to prepare surfaces.

2. Schedule cleaning and painting so that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Protect surfaces not intended to be painted from effects of cleaning and painting operations.

3. Prior to blasting, clean surfaces to be coated or lined of grease, oil and dirt by steaming or detergent cleaning in accordance with SSPC SP 1.

4. Metal and Weld Preparation: Remove surface defects such as gouges, pits, welding and torch-cut slag, welding flux and spatter by grinding to 1/4-inch minimum radius.

5. Abrasive Material:

a. Blast only as much steel as can be coated within same day of blasting.

b. Use sharp, angular, properly graded abrasive capable of producing depth of profile specified herein. Transport abrasive to jobsite in moisture-proof bags or airtight bulk containers. Copper slag abrasives are not acceptable.

c. After abrasive blast cleaning, verify surface profile with replica tape such as Tes-Tex Coarse or Extra Coarse Press-O-Film Tape, or approved equal. Furnish tapes to Engineer.

d. Do not blast if metal surface may become wet before priming commences, or when metal surface is less than 5 degrees F above dew point.

6. Evaluate degree of cleanliness for surface preparation with use of SSPC Pictorial Surface Preparation Standards for Painting Steel Surfaces, SSPC-Vis 1.

7. Remove dust and abrasive residue from freshly blasted surfaces by brushing or blowing with clean, dry air. Test cleanliness by placing 3/4-inch by 4-inch piece of clear Scotch-type tape on blasted surface, then removing and placing tape on 3x5 white index card. Reclean areas exhibiting dust or residue.

D. Coating and Lining Application:

1. Environmental Conditions: Do not apply when metal temperature is less than 50 degrees F; when ambient temperature is less than 5 degrees F above dew point; when expected weather conditions are such that ambient temperature will drop below 40 degrees F within 6 hours after application; or when relative humidity is above 85 percent. Measure relative humidity and dew point by use of sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychometric Tables. Provide dehumidifiers for field-applied coatings and linings to maintain proper humidity levels.

2. Application Procedures:

a. Apply in accordance with manufacturer's recommendations and requirements of this Section. Provide finish free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive over spray, or delaminations.

b. Thin materials only with manufacturer's recommended thinners. Thin only amount required to adjust viscosity for temperature variations, proper atomization and flow-out. Mix material components using mechanical mixers.

c. Discard catalyzed materials remaining at end of day.

3. Thoroughly dry pipe before primer is applied. Apply primer immediately after cleaning surface. Apply succeeding coats before contamination of undersurface occurs.

4. Cure minimum of 24 hours at 77 degrees F before successive coats are applied. During curing process, provide force air ventilation in volume sufficient to maintain solvent vapor levels below published threshold limit value. Apply successive coats within recoat threshold time as recommended by coating or lining manufacturer on printed technical data sheets or through written

communications. Brush blast joints of pipe which have been shop primed and are to receive intermediate and finish coats in field prior to application of additional coats. After interior coats are applied, provide forced-air ventilation in sufficient volume and for sufficient length of time to ensure proper curing before filling pipe with water.

3.03 EXTERNAL COATING SYSTEM FOR BURIED STEEL PIPE

A. Tape Coating System:

1. Joint Protection:

a. Heat Shrink Sleeve: In accordance with AWWA C 216. Provide Aqua-Shield, or approved equal. Apply manufacturer-approved insulating putty at bell step-offs. For welded joints, apply heat-resistant protective sleeve, such as Aqua-Shield AQW-WAB or approved equal, prior to internal welding. Surface preparation: Clean exposed metal with solvent, wire brush, and blast clean in accordance with AWWA C 216 and manufacturer's specifications. Apply sleeve in accordance with manufacturer's specifications. Visually inspect sleeve to verify adhesive flows beyond edge, and there are no cracks or holes. Repair as necessary in accordance with AWWA C 216 and manufacturer's recommendations. Shrink sleeve manufacturer's technical representative shall be available on site at beginning of pipe laying operations, and advise Contractor and Engineer regarding installation, repairs, and general construction methods.

b. Heat-Resistant Tape Coating System: In accordance with AWWA C 209. Polyken or approved equal. Apply manufacturer-approved insulating putty at bell step-offs. Surface Preparation: Clean exposed metal with solvent, wire brush and blast clean in accordance with AWWA C 209 and manufacturer's specifications. Follow with primer, and then tape coating in accordance with manufacturer's specifications. Visually inspect finished coating for damages, flaws, holidays or mislaps. Repair as necessary in accordance with AWWA C 209 and manufacturer's recommendations. Tape manufacturer's technical representative shall be available on site at beginning of pipe laying operations, and advise Contractor and Engineer regarding installation, repairs and general construction methods.

2. Field Application: AWWA C209 around joint cutbacks except as modified:

a. Field-welded joints: Clean shop-primed ends of weld splatter, damaged primer, and rust to achieve required surface preparation prior to field repair of coatings.

b. Extend joint cleaning 4 inches onto existing coating. Completely remove damaged and loose end-coatings.

c. Prior to placing pipe in trench, remove shop-applied primer by abrasive blasting, solvent or other method as approved by Engineer. Avoid damage to adjacent existing coatings.

d. Clean surfaces to achieve surface preparation at least equivalent to SSPC SP 6 in accordance with AWWA C209. Provide solvent that is environmentally safe and compatible with coating system primer.

e. Apply insulating putty onto bell step-off as shown on Drawings. Remove release liner during application.

f. Apply primer immediately prior to application of first layer of tape to achieve maximum bond. Apply tape while primer is still "tacky" with 3-inch minimum overlap over shop-applied coating.

3. Joint Tape:

a. Extend inner wrap minimum of 2 inches onto existing coating on each side of joint. Extend outer wrap minimum of 4 inches onto existing coating each side of joint. Stagger end laps minimum of 6 inches. Overlap adjacent tape wraps at least 1 inch, and overlap seam of outer wrap. Do not allow to be coincident with overlap seam of inner wrap. Wash with Xylol area that will be overlapped.

b. Apply approved joint wrap tape to uncontaminated primer at proper roll body temperature. If necessary, store joint wrap material in heated box up to point of application.

c. Apply joint wrap material to pipe in either spiral or cigarette fashion dependent upon specification. Begin wrapping process 2 to 4 inches onto mill-applied pipe wrap and proceed wrinkle-free up over bell and across joint to spigot side pipe wrap.

d. Apply joint wrap under machine tension of 5 to 10 pounds per inch width. Joint wrap width should narrow (neck down) as material is applied tightly around pipe.

e. Apply first 1/3 and last 1/3 turn of joint material around pipe with less tension to prevent wrap crawlback. Overlap of joint wrap material and system's total thickness as specified in this specification section.

f. End joint wrap process such that its final edge is directed downwards when pipe is placed in ditch to prevent backfill from pulling exposed joint wrap edge.

4. Do not expose tape coatings or heat-shrinkable joint sleeves to harmful ultraviolet light for more than 90 days. Discard (remove) and replace outer layer of tape coating when exposure exceeds 90 days. In case of factory-applied coatings, remove pipe from site for removal and reapplication of outer layer of tape coatings.

5. At option of Engineer, coating system and application may be tested and inspected at plant site in accordance with AWWA C214.

B. Test for holidays:

1. Inspect pipe for holidays and damage to coating.

a. If test indicates no holidays and outer wrap is torn, remove damaged layers of outer wrap by carefully cutting with sharp razor-type knife. Wash with Xylol area to be patched and at least 4 inches of undamaged tape where hand-applied tape wrap will overlap. AWWA C209 cold-applied tape compatible with tapewrapping system applied for each layer of outer-wrap tape that has been removed.

b. If test indicates holiday, remove outer layers and expose inner wrap. Prime exposed area and overlaps with light coat of primer. Firmly press into place patch of two 35-mil inner wrap tape extending 4 inches from affected area in all directions. Second patch to overlap first patch by 2 inches. Perform holiday test of patch to verify satisfactory installation. Wash exposed outer wrap tape with Xylol and prime.

c. For severe outer wrap tape tears or damage, and holiday is not detected, remove outer wrap to boundaries of damaged area, taking care not to damage inner wrap coating. Before replacing outer wrap, apply holiday detector to exposed area to determine that no damage has been made to primary coating. After verification that no holidays exist in underlying tape, clean damaged area and use patch of 35-mil outer wrap tape. Apply as specified herein for repair of areas where bare pipe is exposed.

2. Do not allow bubbles in tape coating system regardless of holiday test results, cut out bubbles and patch as described above as directed by Engineer.

3. Perform test procedure in accordance with NACE Standard RP-02-74. Perform electrical holiday test with 60-cycle current audio detector. Use test voltage below:

Total Coating Thickness (Mils)	Test Voltage (Volts)
20	6,000
30/35	7,500
50	9,000
70	11,500
80	12,000

C. Remove areas having physical damage and recoat. After repairing area, apply holiday detector as stated above to verify area is adequately repaired.

D. Cement mortar coating. AWWA C 205; 1-inch minimum thickness; Cut back from joint ends no more than 2 inches to facilitate joining and welding of pipe.

E. Polyurethane Coating. Comply with requirements of Paragraph 3.02.

3.04 JOINTS AND JOINTING

A. Rubber Gasketed Bell-and-Spigot Joints.

1. Use O-ring gasket with sufficient volume to approximately fill area of groove and gasket material in accordance with AWWA C200. Check each splice in gasket by stretching gasket to at least twice original length of gasket. Visually check stretched splice by rotating 360 degrees. Reject splices showing visible separation or cracks.

2. Equalize rubber gasket cross section after rubber gasket is placed in spigot groove of pipe by inserting tool or bar such as large screwdriver under rubber gasket and moving it around periphery of pipe spigot. Lubricate gaskets with nontoxic water-soluble lubricant before pipe units are joined. Fit pipes together in manner to avoid twisting or otherwise displacing or damaging rubber gasket. Check gaskets after pipe sections are joined with feeler gauge to ensure that no displacement of gasket has occurred at point around circumference after joining. If displacement has occurred, remove pipe section and remake joint as if for new pipe. Remove old gasket and replace before remaking joint.

B. Welded Joints:

1. Conform to requirements of Section 02511 - Water Lines.

2. Field weld to be double-welded lap field joints or full penetration butt welded joints for steel pipe and encasement sleeves for entire circumference.

3. Employ independent certified testing laboratory, approved by Engineer, to perform weld acceptance tests on welded joints. Include cost of such testing in

contract unit price bid for water line. Furnish copies of all test reports to Engineer for review. Test by magnetic particle test method for lap welds and fillet welds or by X-ray methods for butt welds, for 100 percent of all joint welds. Engineer has final decision as to suitability of welds tested.

C. Flanged Joints: Conform to requirements of Section 02511 - Water Lines.

D. Joint Grouting and Testing: Conform to requirements of Section 02511 - Water Lines.

E. Do not allow steel plugs for threaded outlets to project beyond inner surface of pipe shell and seal weld by at least two passes. Apply weld around outside of plug after it has been inserted in final position. Coat outlets and plugs inside and outside as required at field joints on pipe.

3.05 FIELD-APPLIED CEMENT-MORTAR LINING

A. Entrances into Pipeline:

1. Establish means to permit entry and exit of labor, materials and equipment necessary for progress of work, as approved by Engineer.

2. Provide dikes and channeling for diversion of flood and drainage waters away from these openings in pipeline. Use temporary airtight covers over openings to provide proper curing conditions in completed sections of lined pipe. Where operation of equipment requires that end of pipe be left open, install temporary bulkhead inside pipe to eliminate direct draft through pipe over completed sections.

3. Brace closure sections of pipeline left out to facilitate field lining above ground to conform as nearly as possible to shape of pipe in ground and then place cement-mortar lining by machine or hand trowel to same thickness as in adjoining machine-lined sections. Bulkhead sections immediately after being lined to maintain proper curing conditions for period of not less than 48 hours before sections are installed in pipeline. Install these sections of steel pipe.

4. Coat exterior surface of buttstraps and uncoated exterior surface area of steel pipe within excavations in accordance specifications. Place cement-mortar lining inside areas of joints in accordance with specifications.

B. Mixing of Cement-mortar: Mix ingredients for cement-mortar for not less than 1-1/2 and not more than 6 minutes; use mortar promptly after mixing for lining pipe. Do not use mortar that has attained its initial for lining. Do not retemper mortar. Add water to mix last.

C. Placing Cement-Mortar Lining:

1. Complete joint work, backfill and welding before cement-mortar lining begins. After cement-mortar lining has cured hydrostatic testing of pipe can begin.

2. Provide provisions necessary for Engineer to conduct inspections of work in safe and thorough manner during and after initial application of mortar and after necessary repairs made. Include, as minimum, space on application machine, and adequate lighting to inspect gross surface areas

3. Comply with ASTM C494 and with manufacturer's recommendations when using chemical admixtures, bonding agents, accelerators, and other additives.

4. Remove dirt, debris, oil, grease and loose mill scale and rust from interior surfaces of pipe, and scrape or brush surface with stiff bristle brush and/or water blast as may be necessary, and approved by Engineer, to ensure clean surfaces for successful application of cement-mortar lining. Interior surfaces to be approved by Engineer prior to placing lining.

5. Provide cement-mortar lining uniform in thickness along entire length of pipe. Provide cement-mortar no less than 1/2 inch over all surfaces with tolerance of plus 1/8 inch, and no allowance for minus tolerance.

6. Mechanically control travel of machine and rates of discharge of mortar to produce uniform thickness of lining without segregation around perimeter and along length of pipe.

7. Check finished surface by placing 12-inch straightedge parallel to axis of pipe along surface of straight section of lining. At no point will space between lined surface and straightedge be greater than 1/16 inch.

8. Provide smooth finished surface, within tolerances specified. Repair or replace surface irregularities including corrugations, ripples, or pits in any direction, to satisfaction of Engineer. Remove defective lining material, including, sand pockets, voids, oversanded areas, blisters, delaminations, or unbounded areas, cracked areas, irregular surfaces, and unsatisfactory thin spots. Remove to pipe wall and area repaired to full thickness of mortar lining.

9. Repair cracks 1/16 inch and larger to satisfaction of Engineer.

10. Place cement-mortar lining by machine having following features:

    a. An applicator head which can be centered within pipe and which will centrifugally project mortar against wall of pipe at high velocity producing dense, uniformly distributed mortar on wall of pipe.

    b. Equipped with mechanically driven, rotating steel trowels that immediately follow applicator, providing smooth, hard surface without

spiral shoulders. Compensate for torque so that machine will sit true in pipe and trowel faces will not vary in angle with mortar face during complete 360-degree cycle. Clean trowels at frequent intervals to prevent accumulated mortar from obtaining initial set resulting in sanded or unglazed finish. Continuously operate trowels during application of cement-mortar and forward progress of lining machine.

c. Design applicator so that nothing will come in contact with troweled surface until it has attained final set, and so that forward progress of machine and mechanical placing of mortar can be controlled to assure uniform thickness of lining.

11. Cement-mortar Lining: Adhere to steel at all points; provide consistent thickness except that lining of bell end of pipe where lining is to be thicker in order to fill depression and make smooth surface.

12. Immediately prior to application of cement-mortar lining, sweep and clean off slime, dirt, loose rust, loose mill scale, and other foreign materials. Free interior surface of pipe after cleaning of accumulated water on pipe wall or at joints.

13. After receiving its finish troweling, do not roughen lining by rebound material or by mortar direct from machine.

14. Temporarily close outlets in pipeline with easily removable stoppers to prevent spun mortar from being thrown into such openings. After lining is applied, remove stoppers from outlets and repair lining damaged by removal of stoppers. Point outlet openings up to provide smooth flow.

D. Hand Finishing:

1. Repair defective areas in machine-applied lining and unlined joints by hand patching to yield lining equal to that required for machine-applied troweled lining.

2. Provide nonshrink grout for patching or lining joints as specified in this Section.

3. Clean defective areas of loose foreign material and moisten with water just prior to application of hand-applied mortar.

4. Use steel finishing trowels for hand application of cement-mortar.

5. Complete hand finishing required in given pipe section not later than day following machine application of mortar lining to that particular pipe section, whether normal working day or otherwise. Slow down or stop machine

application of mortar lining to allow time for hand patching.

E. Curing of Lining: Begin curing operations immediately after completing any portion of mortar lining. Close pipe by airtight bulkheads, and maintain moist atmosphere in completed section of pipe to keep lining damp and to prevent evaporation of entrained water from mortar lining. Humidify air introduced into pipe for ventilating or curing purposes and maintain moist atmosphere inside pipe until Engineer accepts Work.

3.06 INSPECTION (EXCEPT MORTAR COATED PIPE)

A. Include cost of inspection described in Paragraph 3.06-B, Inspection, in contract unit price for water line. Furnish copies of certified inspection reports to Engineer for review.

B. Holiday Test and Adhesion Test: Provide services of independent coating and lining inspection service or testing laboratory with qualified coating inspectors. Provide inspections by NACE trained inspectors under supervision of NACE Certified Coatings Inspector having Level III Certification.

3.07 COATINGS AND LININGS INSPECTION RESPONSIBILITIES

A. Contractor is responsible for quality control of coatings and linings applications and testing and inspection stipulated in this Section. Engineer is responsible for quality assurance and reserves right to inspect or acquire services of independent third-party inspector who is fully knowledgeable and qualified to inspect surface preparation and application of high performance coatings at phases of coatings and linings, field or shop applied. Contractor is responsible for proper application and performance of coatings and linings whether or not Engineer provides such inspection.

B. Cement Mortar Lining and Joint Finish: Finished surface of lining and joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

3.08 FIELD REPAIR PROCEDURES AND SPECIAL FITTINGS APPLICATION FOR CEMENT MORTAR LINING

A. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in concrete surfaces with nonshrink grout. Repair defects by cutting out unsatisfactory material and replacing with nonshrink grout, securely bonded to existing concrete. Finish to make junctures between patches and existing concrete as inconspicuous as possible. After each patch has stiffened sufficiently to allow for greatest portion of shrinkage, strike off grout flush with surrounding surface.

B. Areas greater than 6 inches in diameter:

1. Remove defective lining down to bare steel by chipping, making sure care is taken to prevent further lining damage. Ends of lining where defective lining is removed are to be left square and uniform not feathered.

2. Clean bare steel with wire brush to remove loose or other foreign matter.

3. Remove existing wire reinforcement and replace. Overlap new reinforcement to existing reinforcement by 1/2 inch. Secure reinforcement, against wall of pipe, at frequent intervals, by tack welding to pipe.

4. Prepare cement mortar mixture. Mixture to compose of Portland Type II cement, sand, and water. Proportions of sand to cement not to exceed 3 parts sand to 1 part cement, by weight. Use only enough water to obtain proper placement characteristics. Set up time before mixture is to be discarded is to be no longer than 1/2 hour. Nonshrink grout may also be used. Do not use combination of cement mortar and nonshrink grout within same repair.

5. Apply WELD-CRETE, or approved equal, concrete bonding agent to bare steel and interface of existing lining. After bonding agent is applied to steel and lining new mix must be applied within 10 minutes.

6. Apply cement mortar to repair area 1/2 inch thick then hand trowel to achieve smooth dense finish, making sure wire is not left exposed. To ensure proper thickness while placing new mortar, check thickness with 1/2 inch long wire gauge.

7. Curing: Place plastic sheeting over repair area, use tape to adhere plastic to area surrounding repair area. Let cure for 4 days then remove plastic sheeting.

END OF SECTION

Section 02514

FIRE HYDRANT ASSEMBLY

1.0 GENERAL

1.01 SECTION INCLUDES

A Fire hydrants.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 02634 – Ductile Iron Pipe and Fittings
4. Section 02635 – Steel Pipe and Fittings
5. Section 02534 – PVC Pipe
6. Section 02510 – Water Mains

C Referenced Standards:
1. National Fire Protection Association (NFPA)
2. American Water Works Association (AWWA)
3. American National Standards Institute (ANSI)
4. National Association of Corrosion Engineers (NACE)
5. Food and Drug Administration (FDA)
6. Steel Structures Painting Council (SSPC)
7. Texas Commission on Environmental Quality (TCEQ)
8. National Sanitation Foundation (NSF)

1.02 MEASUREMENT AND PAYMENT

A Measurement for installation of fire hydrants is on a per each basis, complete in place. Payment includes all valves, fittings, bedding, backfill, and thrust blocking required for the installation of the fire hydrant assembly.

B If fire hydrant leads are included as a Bid Item, measurement will be on a linear foot basis. Separate payment will be made for open cut and augered leads.

C Measurement for removing and salvaging of fire hydrants is on a per each basis. Payment includes removing hydrant and valve if available, plugging lead, and removing materials from site or returning salvaged fire hydrants to Owner.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

1. Shop drawing(s) for proposed hydrant: Include model number, parts list, and material specifications, unique drawing number and descriptive legend identifying hydrant.
2. Material safety data sheets for lubricants.
3. Affidavit of compliance for coating materials.
4. Certified hydraulic performance test report for proposed hydrant.

2.0 PRODUCTS

2.01 HYDRANT MATERIALS

A Hydrants: AWWA C502; dry barrel design; tamper resistant; same manufacturer throughout project.

1. O-Ring Seal Packing: Prevent water leakage between barrel and lubrication chamber. Provide dynamic seals of Buna "N" or other oil resistant material and static seals of Buna "N" or other approved synthetic rubber.
2. Bronze: Hydrant components in waterway to contain not more than 15 percent zinc and not more than 8 percent lead.
3. Acceptable Manufacturer: Mueller Super Centurian 250, American Darling B-84-B, or East Jordan Iron Works WaterMaster 5CD250.

B Operating Stems: Everdur, or other high-quality non-corrodible metal where threads are located in barrel or waterway. Bronze-to-bronze working parts in waterway; genuine wrought iron or steel where threads are not located in barrel or waterway, bronze bushed at penetration of stuffing box; seal threads against contact with water regardless of open or closed position of main valve. Connect operating stems with breakable coupling.

C Main Valve (shut-off valve): Circular; compression-type; closes with line pressure; minimum opening of 5-1/4 inches in diameter. Seal bottom end of stem threads from contact with water with cap nut.

D Valve Mechanism: Bronze valve seat ring threaded into bronze drain ring; seat ring and main valve assembly removable from above ground through upper barrel with lightweight seat removal wrench; breakable stem coupling opposite barrel breakaway; bronze or corrosion-resistant pins and locking devices; bronze valve stem sleeve, O-ring seals and travel stop; sealed lubricating reservoir at top and bottom which fully lubricates threads and bearing surfaces when opening or closing main valve; thrust bearing or lubricated thrust collar for operating assembly. Lubricants: Food Grade. Valve Seat: Molded "Natural" rubber; scale durometer rating of 90 ±5; minimum thickness of 1/2 inch. Natural Rubbers: Resistant to microbiological attack.

E Lower Hydrant Barrel: Single piece coupled to upper barrel to allow 360° rotation of upper barrel. Bury Length: Distance from bottom of inlet to ground line as specified. Ground Line: Clearly marked on barrel. Indicate inside diameter and wall thickness (with tolerances) for upper barrel, lower barrel, and bonnet sections. Show dimensions at minimum sections to demonstrate compliance with Paragraph 3.2.6 of AWWA C502.

F Extensions: Permit use of one or more standard extensions available from manufacturer in lengths from 6 inches to 60 inches in 6 inch increments.

G Provide hydrants with automatic, positively operating, non-corrodible drain or drip valve to drain hydrant completely when main valve is shut. Bronze or corrosion resistant drain line. Tapping of drain holes is not required.

H Inlet Connection: Elbow with AWWA Standard bell designed for 6-inch mechanical joint, restrained push-on, or flanged joint and valves. Flanged ends shall comply with ANSI/ASME B16.1, class 125 flanges. Joints: ANSI A21.11; AWWA C111.

I Operating Nut and Hold-down Nuts: Stainless steel or cast or ductile iron with bronze inserts or, as an alternative, provide security device with bronze operating nut. Any such security devices shall not require special tools for normal off/on operation of hydrant. Fabricate hold-down assemblies of suitable metallic materials for service intended.

J Field-Replaceable Nozzles: NFPA No. 194, ANSI B26-1925; mechanically attached to hydrant body counterclockwise; sealed with O-rings and mechanically located into place; provide two hose nozzles with 2-1/2 inch nominal inside diameter and one pumper nozzle with 4.492" nominal inside diameter; National Standard Threads; lock in place with security device.

K Pumper Nozzle: Allow a minimum unobstructed radius of 10 inches from threaded surface of nozzle throughout path of travel of wrench or other device used to fasten hose to nozzle.

L Nozzle Caps: Security chains to hydrant barrel, minimum 1/8 inch diameter; "Natural" rubber or neoprene gasket seals.

M Hydrant shoe with 6-inch cast or ductile-iron pipe diameter inlet, flanged, swivel or slip joint with harnessing lugs for restrained joints. Underground flanging shall incorporate minimum of six, full, 3/4-inch stainless steel bolts or four 5/8-inch diameter stainless steel bolts. All bolts and nuts shall be stainless steel.

N Provide traffic model hydrants equipped with safety flange on hydrant barrel and stem. Equip body of hydrant with breakable flange, or breakable bolts, above finish grade.

O Lubricants: Food grade oil or grease meeting requirements of FDA 21CFR178.3570 and manufactured with FDA approved oxidation inhibitors.

P Hydrant Painting:

1. COLOR CODE (BONNETS)

Main Size	
6" and less	Gloss White Code No 225A120
8"	Safety Orange Code No 225A122
10" and 12"	John Deere Green Code No 225A133
16" and 20"	John Deere Yellow Code No 225A138
22" and up	Safety Red Code No 225A123

2. COLOR CODE

Fire Hydrant Barrel	Safety Blue Code No 225A120
Fire Hydrant Caps	(Same as Bonnet Color)

Q Shop coated as follows:

1. Exterior Above Traffic Flange (including bolts and nuts)
   a. Surface Preparation: SSPC-SP10 (NACE 2); near white blast cleaned surface.
   b. Fire hydrants shall be power coated with zinc rich primer followed by a polyester powder coating of 10 to 12 mils, shall meet all the requirements of ANSI/AWWA C-550 (latest edition) and AAMA 2604.

2. Exterior Below Traffic Flange:
   a. Surface Preparation: SSPC-SP10 (NACE 2); near white blast cleaned surface.
   b. Fire hydrants shall be power coated with zinc rich primer followed by a polyester powder coating of 10 to 12 mils, shall meet all the requirements of ANSI/AWWA C-550 (latest edition) and AAMA 2604.
3. Interior Surfaces Above and Below Main Valve:
   a. All materials used for internal coating of hydrant interior ferrous surfaces must conform to ANSI/NSF Standard 61 as suitable for contact with potable water as required by TCEQ, Chapter 290, Subchapter D: Rules and Regulations for Public Water Systems.
   b. Surface Preparation: SSPC-SP10 (NACE 2); near white blast cleaned surfaces.
   c. Coating: Powder coating in accordance with manufacturer's recommendation.
4. General Coating Requirements:
   a. Coatings: Applied in strict accordance with manufacturer's recommendations. No requirements of this specification shall cancel or supersede written directions and recommendations of specific manufacturer so as to jeopardize integrity of applied system.
   b. Hydrant supplier shall furnish an affidavit of compliance that all materials and work furnished complies with requirements of this specification and applicable standards referenced herein.

2.02 HYDRANT PERFORMANCE STANDARDS

A Hydraulic Performance Standards:

1. Provide hydrants capable of a free discharge of 1500 gpm or greater from single pumper nozzle at a hydrant inlet static pressure not exceeding 20 PSIG as measured at or corrected to hydrant inlet at its centerline elevation.
2. Provide hydrants capable of a discharge of 1500 gpm or greater from single pumper nozzle at a maximum permissible head loss of 8.0 psig (when

corrected for inlet and outlet velocity head) for an inlet operating pressure not exceeding 37 psig as measured at or corrected to hydrant inlet at its centerline elevation.

B Hydraulic Performance Testing: AWWA C502; conduct certified pressure loss and quantity of flow test by qualified testing laboratory on production model (5-foot bury length) of hydrant (same catalog number) proposed for certification. Submit certified test report containing following information:

1. Date of test, no more than five years prior to date of proposed use, on fire hydrant with similar hydraulic characteristics.
2. Name, catalog number, place of manufacture, and date of production of hydrant(s) tested.
3. Schematic drawing of testing apparatus, containing dimensions of piping elements including:
   a. Inside diameter and length of inlet piping.
   b. Distance from flow measuring points to pressure measurement point.
   c. Distance from flow and pressure monitoring points to hydrant inlet.
   d. Distance from pressure monitoring point to nozzles.
   e. Inside diameter and length of discharge tubing.
4. Elevation of points of measurement, inlet, and reports, or certificates documenting accuracy of measuring devices used in test.
5. Conduct test on at least three separate hydrants of same fabrication design. Inlet water temperature: 70° F $\pm$ 5° F.

C Provide hydrants equipped with breakable barrel feature and breakable valve stem coupling such that vehicular impact will result in clean and complete break of barrel and valve stem at breakable feature. Provide hydrant shutoff valve which remains closed and tight against leakage upon impact.

2.03 LEADS

A Branches (Leads): Conform to requirements of Section 02634 – Ductile-Iron Pipe and Fittings, Section 02635 – Steel Pipe and Fittings, Section 02534 – PVC Pipe, and section 02532W - HDPE.

3.0 EXECUTION

3.01 INSTALLATION

A Set fire hydrant plumb and brace at locations and grades as shown on Plans. When barrel of hydrant passes through concrete slab, place a piece of standard sidewalk expansion joint material, ¾ inch thick, around section of barrel passing through concrete.

B Locate nozzle centerline minimum 18 inches above finish grade.

C Place 12-inch x 12-inch yellow indicators (plastic, sheet metal, plywood, or other material approved by Engineer) on pumper nozzles of new or relocated fire hydrants

installed on new mains not in service. Remove indicators after new main is tested and approved by Engineer.

D Do not cover drain ports when placing concrete thrust block.

E Lubricate hydrants with food grade oil or with grease meeting requirements of FDA 21CFR178.3570 and manufactured with FDA approved oxidation inhibitors.

F Accomplish replenishment of lubricant for hydrant working parts without removing hydrant bonnet. Store lubricant system in reservoir. Lubricate bearing surfaces and working parts during normal operation of fire hydrant.

G All changes in profile from approved plans due to obstructions not shown on plans which require a change in depth of bury of fire hydrant shall be approved in writing by Engineer for design prior to installation of hydrant. Any adjustment required in flow line of water main or to barrel length of fire hydrant shall be incidental to unit price of fire hydrant and no separate payment shall be made for such adjustments.

H Remove and dispose of or salvage fire hydrants shown on Plans.

I Owner may, at any time prior to or during installation of hydrants for a specific project, randomly select a furnished hydrant for disassembly and laboratory inspection, at Owner's expense, to verify compliance with Owner's requirements. If such hydrant is found to be non-compliant, replace at Contractor's expense, all or a portion of furnished hydrants with hydrants that comply with Owner's requirements.

J Install leads in accordance with Section 02510 – Water Mains.

END OF SECTION

Section 02515

WATER TAP AND SERVICE LINE INSTALLATION

1.0 GENERAL

1.01 SECTION INCLUDES

A Tapping existing mains and furnishing and installing new service lines for water.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 02318 – Excavation and Backfill for Utilities
3. Section 02520 – Valve Boxes, Meter Boxes, and Meter Vaults

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 2737, "Standard Specification for polyethylene (PE) Plastic Tubing"
2. American Water Works Association (AWWA)
   a. AWWA C800 Standard Underground Service Line Valves and Fittings
   b. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4" – 12" for Water Distribution

D Definitions:
1. Short Side Connection - service line connecting proposed curb stop, located inside water meter box, to water main on same side of street.
2. Long Side Connection - service line connecting proposed curb stop, located inside water meter box, to water main on opposite side of street or from center of streets where supply main is located in street center such as boulevards and streets with esplanades.

1.02 MEASUREMENT AND PAYMENT

A Measurement for installation of 1 inch water taps and service lines is on a per each basis. Separate measurements will be made for "Short Side" and "Long Side" connections.

B Measurement for installation of 2 inch water taps and service lines is on a per each basis. Separate measurements will be made for "Short Side" and "Long Side" connections.

C Payment for installation of water taps and service lines includes locating water main, tap installation and connection to meter, restoring site, excavation, bedding, backfill, compaction, push-under, etc., and all other labor and materials required to complete installation as indicated on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit manufacturer's product data for approval.

2.0 PRODUCTS

2.01 MATERIALS

A Polyethylene Tubing - SDR 9 CTS.

B Corporation Stops: AWWA C800 as modified herein:
1. Inlet End: AWWA standard thread.
2. Valve Body: Tapered plug type, O-ring seat ball type, or rubber seat ball type.
3. Outlet End: Compression type fitting for use with type-K, soft copper as well as CTS.

C Provide taps for various water main types and sizes in accordance with following schedule:

PIPE TAPPING SCHEDULE		
WATER MAIN TYPE AND DIAMETER	**SERVICE SIZE**	
	1"	**2"**
4" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS
4" Asbestos Cement	WBSS	DSS, WBSS
4" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS
6" and 8" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS
6" and 8" Asbestos Cement	DSS, WBSS	DSS, WBSS
6" and 8" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS
6" and 8" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS
12" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS
12" Asbestos Cement	DSS, WBSS	DSS, WBSS
12" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS
16" and Up Cast Iron or Ductile Iron	DWBSS	DWBSS

16" and Up Asbestos Cement	DWBSS	DWBSS
16" and Up PVC (AWWA C900)	DWBSS	DWBSS

DSS – Dual Strap Saddles
WBSS – Wide Band Strap Saddles
DWBSS – Dual Wide Band Strap Saddles
*Mueller H-15092, or equal

D Dual Strap Saddles: Red brass body and straps; ductile-iron; vinyl-coated body and straps; or ductile-iron, vinyl-coated body and stainless-steel straps.

E Taps for PVC Water Mains: Use dual-strap or single, wide-band strap saddles which provide full support around circumference of pipe and bearing area of sufficient width along axis of pipe, 2 inches minimum, ensuring that pipe will not be distorted when saddle is tightened. Romac Series 101N wide-band, stainless-steel tapping saddle with AWWA standard thread (Mueller thread) or equal.

F Taps for Steel Pipe: Not allowed, unless specifically approved by Engineer. Use saddle only if tap is approved on steel pipe.

G Curb Stops and Brass Fittings: All Brass fittings shall be lead free conforming to the latest EPA's guideline. AWWA C800 as modified herein.

1. Inlet End: Compression-type fitting.
2. Valve Body: Straight-through or angled, meter-stop design equipped with the following:
   a. O-Ring seal straight plug type.
   b. Rubber seat ball type.
3. Outlet End: Female, iron-pipe thread or swivel-nut, meter-spud thread on 1 inch stops and 2-hole flange on 2 inch sizes.
4. Fittings: Ford or approved equal; use same size open end wrenches and tapping machines as used with respective Ford fittings.
5. Factory Testing of Brass Fittings:
   a. Submerge in water for 10 seconds at 85 psi with stop in both closed and open positions.
   b. Reject any fitting that shows air leakage. Owner may confirm tests locally. Entire lot from which samples were taken will be rejected when random sampling discloses unsatisfactory fittings.

H Angle Stops: In accordance with AWWA C800; ground-key, stop type with bronze lock-wing head stop cap; inlet and outlet threads conform to application tables of AWWA C800; and inlets compression connection.

1. Outlet for 1-inch size: Meter swivel nut with saddle support.
2. Outlet for 2 inch size: O-ring sealed meter flange, iron pipe threads.

I Fittings: In accordance with AWWA C800 and:

1. Castings: Smooth, free from burrs, scales, blisters, sand holes, and defects which would make them unfit for intended use.

2. Nuts: Smooth cast and have symmetrical hexagonal wrench flats.
3. Thread fittings, of all types, shall have N.P.T. or AWWA threads, and male threaded ends shall be protected in shipment by plastic coating or other equally satisfactory means.
4. Compression tube fittings shall have Buna-N beveled gasket.
5. Stamp of manufacturer's name or trademark and size on body.

3.0 EXECUTION

3.01 GENERAL

A Set service taps at right angles to proposed meter location and locate taps in upper pipe segment within 45 degrees of pipe springline unless otherwise approved by Engineer.

B For service lines and lateral connections larger than those allowed in this Section, Part 2.01C, branch connections must be used.

C All 2-inch and smaller service taps on pressurized water mains: Use tapping machine manufactured for pressure tapping purposes.

D Install service lines in open-cut trench in accordance with Section 02318 – Excavation and Backfill for Utilities except that service lines under all paved roadways, other paved areas and areas indicated on Plans shall be installed in bored hole as specified in this Section.

E Unless otherwise approved by Engineer, lay service lines with minimum of 30 inches of cover as measured from top of curb or, in absence of curbs, from centerline elevation of crowned streets or roads. Provide minimum of 18 inches of cover below flow line of all ditches to service lines, unless otherwise approved by Engineer.

F Service lines across existing street (push-unders): Pull service line through prepared hole under paving. Only full lengths of tubing will be used. Take care not to damage tubing when pulling it through hole. A compression-type union is only permitted if Contractor cannot span underneath pavement with a full length of tubing. Contractor is allowed one compression-type union for each full length of tubing, provided it is not under the pavement.

G Maintain service lines free of dirt, coupons and foreign matter at all times.

H Install service lines per City of Baytown. Standard Details.

I Locate water meters in accordance with City of Baytown Standard Details. Contact Engineer when major landscaping or trees conflict with service line and meter box location. No additional payment will be made for work on customer side of meter.

J Joints

1. Minimum joint spacing for 1 inch tubing shall be in multiples of 60 feet and for 2 inch tubing shall be in multiples of 40 feet.

2. Cut tubing squarely by using an approved cutting tool and avoiding excessive pressure on the cutting wheels which might bend or flatten pipe walls.
3. For compression fittings, cut tubing squarely prior to insertion into the fitting. Final assembly shall be in accordance with manufacturer's recommended procedure.

K Bends

1. Gradual changes in direction may be made by bending PE pipe. The bending radius should not be less than the coil radius when bending with the coil.

3.02 CURB STOP INSTALLATION

A Set curb stops or angle stops at outer end of service line inside of meter box. Secure opening in curb stop to prevent unwanted material from entering. In close quarters, make an "S" curve in the field. No flattening of tube. In all 1-inch services, install meter coupling, swivel-nut, or curb stop ahead of meter. Install straight meter coupling on outlet end of meter.

3.03 SEQUENCE OF OPERATIONS

A Open trench for proposed service line in accordance with Section 02318 – Excavation and Backfill for Utilities.

B Install curb stop on meter end of service line.

C With curb stop open and prior to connecting service line to meter in slack position, open corporation stop and flush service line thoroughly. Close curb stop, leaving corporation stop in full-open position.

D Check service line for apparent leaks. Repair any leaks before proceeding.

E Call Project Representative to schedule inspection prior to backfilling. After inspection, backfill in accordance with Section 02318 – Excavation and Backfill for Utilities.

F Install meter box centered over meter with top of lid 3-inches above finished grade for grasses or landscaped areas, and flush with finished grade for paved areas. Meter box: Refer to Section 02520 – Valve Boxes, Meter Boxes, and Meter Vaults.

END OF SECTION

Section 02520

VALVE BOXES, METER BOXES, AND METER VAULTS

1.0 GENERAL

1.01 SECTION INCLUDES

A Valve boxes for water service.

B Meter boxes for water service.

C Meter vaults for water service.

D References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 03300 – Cast-in-Place Concrete
4. Section 02542 – Concrete Manholes and Accessories
5. Section 02318 – Excavation and Backfill for Utilities
6. Section 01140 – Contractor's Use of Premises

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for valve boxes under this Section. Include cost in Bid Items for which this Work is a component.

B No separate payment will be made for installation of meter boxes furnished by the Owner under this Section. Include cost of installation of meter boxes in Bid Items for which the Work is a component.

C Measurement for installation of meter vaults is on a per each basis for each meter vault type and size, complete in place. Payment includes all labor and materials required to complete installation as indicated on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit manufacturer's product data for following items for approval:
1. Each type of valve box and lid.
2. Each type of meter box and cover.
3. Each type of meter vault frame and cover.

C Submit Shop Drawings for cast-in-place meter vaults for approval if proposed construction varies from Plans.

D Submit manufacturer's certification that meter boxes purchased for Work meet the requirements of this Section.

2.0 PRODUCTS

2.01 VALVE BOXES

A Provide adjustable, cast-iron, screw-type, valve boxes as manufactured by Bass and Hays Foundry, Inc., or approved equal. Design of valve box shall minimize stresses on valve imposed by loads on box lid.

B Cast the word “WATER” into lid, 1/2 inch in height and raised 3/32 inch, for valves serving potable water lines.

C Provide 6-inch PVC, Class 150, DR 18, riser pipes.

D Concrete for valve box placement:

1. For locations in new concrete pavement, use strength and mix design of new pavement.
2. For other locations, use class "A" concrete, with minimum compressive strength of 3000 psi, conforming to requirements of Section 03300 – Cast-in-Place Concrete.

2.02 METER BOXES

A Refer to City of Baytown Standard Details or contact the Public Works Department for list of acceptable products.

2.03 METER VAULTS

A Meter vaults may be constructed of precast concrete, cast-in-place concrete or solid masonry unless a specific type of construction is required by Plans.

B Concrete for meter vaults: Class A concrete, conforming to requirements of Section 03300 – Cast-in-Place Concrete, with minimum compressive strength of 4000 psi at 28 days.

C Vaults for meters 3” and greater shall be procured through the City’s utility billing department.

3.0 EXECUTION

3.01 EXAMINATION

A Obtain approval from the City Engineer or designee for location of meter vault.

B Verify lines and grades are correct.

C Verify compacted subgrade will support loads imposed by vaults.

3.02 VALVE BOXES

A Provide riser pipe with suitable length for depth of cover indicated on Plans or to accommodate actual finish grade.

B Install adjustable valve box and riser piping plumbed in a vertical position. Provide 6 inches telescoping freeboard space between riser pipe top butt end, and interior contact flange of valve box, for vertical movement damping. Riser may rest on valve flange, or provide suitable footpiece to support riser pipe.

C Paint covers of new valve boxes as directed by the Owner.

3.03 METER BOXES

A Install plastic boxes in accordance with manufacturer's instructions.

B Construct concrete meter boxes to dimensions shown on Plans.

C Adjust top of meter boxes to conform to cover elevations specified in this Section, 3.05 "Frame and Cover for Meter Vaults".

D Do not locate under paved areas unless approved by Engineer. Use approved traffic-type box with cast iron lid when meter must be located in paved areas.

3.04 METER VAULTS

A Construct concrete meter vaults to dimensions and requirements shown on Plans. Do not cast in presence of water. Make bottom as uniform as practicable.

B Precast Meter Vaults:

1. Install precast vaults in accordance with manufacturer's recommendations. Set level on a minimum 3 inch thick bed of sand conforming to the requirements of Section 02318 – Excavation and Backfill for Utilities.
2. Seal lifting holes cement-sand mortar or non-shrink grout.

C Meter Vault Floor Slab:

1. Construct floor slabs of 6-inch-thick reinforced concrete. Slope floor 1/4 inch per foot toward sump. Make sump 12 inches in diameter, or 12 inches square, and 4 inches deep, unless other dimensions are required by Plans. Install dowels at maximum of 18 inches, center-to-center, or install mortar trench for keying walls to floor slab.
2. Precast floor slab elements may be used for precast vault construction.

3.05 FRAME AND COVER FOR METER VAULTS

A Diamond Plate Aluminum as follows:

1. In unpaved areas, set top of meter box or meter vault cover 2 to 3 inches above natural grade.
2. In sidewalk areas, set top of meter box or meter vault cover 1/2 to 1 inch above adjacent concrete.

3.06 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises

B Backfill and compact in accordance with Section 02318 – Excavation and Backfill for Utilities.

C In unpaved areas, slope backfill around meter boxes and vaults to provide a uniform slope 1 to 5 from top to natural grade.

D Meter boxes are not allowed in sidewalk.

END OF SECTION

Section 02530

GRAVITY SANITARY SEWERS

1.0 GENERAL

1.01 SECTION INCLUDES

A Gravity sanitary sewers and appurtenances, including cleanouts, stacks, service connections, and reconnections.

B References to Technical Specifications:
1. Section 02415 – Augering Pipe or Casing for Sewers
2. Section 01200 – Measurement and Payment Procedures
3. Section 01350 – Submittals
4. Section 01450 – Testing Laboratory Services
5. Section 01500 – Temporary Facilities and Controls
6. Section 01570 – Trench Safety System
7. Section 02318 – Excavation and Backfill for Utilities
8. Section 01564 – Control of Ground Water and Surface Water
9. Section 02220 – Site Demolition
10. Section 01140 - Contractor's Use of Premises

C Reference Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 1784, "Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds"
   b. ASTM F 477, "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe"
   c. ASTM D 3034, "Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings"
   d. ASTM F 679, "Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings"
   e. ASTM F 949, "Standard Specification for Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings"
   f. ASTM D 794, "Standard Specification for Poly Vinyl Chloride (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter"
   g. ASTM D 2241, "Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)"
   h. ASTM D 3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals"
   i. ASTM D 3139, "Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals"
   j. ASTM D 2444, "Standard Test Method for Determination for the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)"

k. ASTM F 714, "Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter"
l. ASTM D 2657, "Standard Practice for Heat Fusion Joining and Polyolefin Pipe and Fittings"
m. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"
n. ASTM D 3350, "Standard Specification for Polyethylene Plastic Pipe and Fittings Materials"
o. ASTM D 3681, "Standard Test Method for Chemical Resistance of Fiberglass (Glass-Fiber Reinforced Thermosetting-Resin) Pipe in a Deflected Condition"
p. ASTM D 4161, "Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals"
q. ASTM D 3262, "Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe"
r. ASTM D 3754, "Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe"
s. ASTM D 618, "Standard Practice for Conditioning Plastics for Testing"
t. ASTM C 828, "Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines"
u. ASTM C 924, "Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method"
v. ASTM F 1417, "Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air"

2. American Water Works Association (AWWA)
   a. AWWA C 900 Polyvinyl Chloride (PVC) Pressure Pipe, 4" – 12" for Water Distribution
   b. AWWA C 905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters, 14in. Through 36 in.
3. Plastic Pipe Institute (PPI)
   a. PPI TR3, "Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe"
4. Texas Commission on Environmental Quality (TCEQ)
5. Texas Administrative Code (TAC)

1.02 MEASUREMENT AND PAYMENT

A Measurement of pipe installed at depths 8-feet and less by open cut method is on a linear foot basis, measured and complete in place. Measurement will be taken along the center line of the pipe from center line to center line of manholes, except for pipe in casing or augered installation.

B Payment includes sewer pipe, excavation, bedding, backfill and special backfill, shoring, earthwork, connections to existing manholes and pipe, stacks, cleanouts,

accessories, inspection and testing. Depths beyond 8' will be paid by 2 vertical feet increments.

C Refer to Section 02415 – Augering Pipe or Casing for Sewers for measurement and payment of augered sewer pipe.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit inspection reports, testing reports, and video tape of television inspections as directed by Engineer.

C Submit proposed methods, equipment, materials and sequence of operations for Gravity Sanitary Sewer construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.

1.04 QUALITY ASSURANCE

A Qualifications. Gravity Sanitary Sewer shall be watertight both in pipe-to-pipe joints and in pipe-to-manhole connections. Perform testing in accordance with this Section and Section 01450 – Testing Laboratory Services.

B Regulatory Requirements.

1. Install Gravity Sanitary Sewer to meet the minimum separation distance from any potable water line, as scheduled below. The separation distance is defined as the distance between the outside of the water pipe and the outside of the sewer pipe. When possible, install new Gravity Sanitary Sewers no closer to water lines than 9 feet in all directions. Where this separation distance cannot be achieved, new Gravity Sanitary Sewers shall be installed as specified in this Section.
2. Make notification to the Engineer if water lines are uncovered during Gravity Sanitary Sewer installation where the minimum separation distance cannot be maintained.
3. Lay Gravity Sanitary Sewers lines in straight alignment and grade.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A Inspect pipe and fittings upon arrival of materials at the Project Site.

B Handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear, or free fall. Do not drag pipe and fittings along the ground. Do not roll pipe unrestrained from delivery trucks.

C Use mechanical means to move or handle pipe. Employ acceptable clamps, rope or slings around the outside barrel of pipe and fittings. Do not use hooks, bars, or other devices in contact with the interior surface of the pipe to lift or move lined pipe

2.0 PRODUCTS

2.01 GASKET MATERIAL FOR USE IN POTENTIALLY CONTAMINATED AREAS

A Gravity Sanitary Sewer pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following Gasket Material for the noted contaminants:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacturer

2.02 POLYVINYL CHLORIDE (PVC) PIPE

A Use PVC compounds in the manufacture of pipe that contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.

B Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for a rating of 4000 psi for water at 73.4° F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage. All pipe used for gravity sanitary sewer shall be green.

C Gaskets:

1. Gaskets shall meet the requirements of ASTM F477. When no contaminant is identified, use elastomeric factory-installed gaskets to make joints flexible and watertight.

D Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.

E PVC Gravity Sanitary Sewer pipe shall be green in color and shall be in accordance with the provisions in the following table:

WALL TYPE	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed Can-Tex Carlon Diamond	Approved	D 3034	SDR 26 / PS 115	6" to 15"
		Approved	F 679	SDR 26 / PS 115	18" to 48"
		Approved	AWWA C900	DR 18 / N/A***	4" to 12"
		Approved	AWWA C905	DR 18 / N/A***	14" to 36"
Profile*	Contech A-2000**	Only when included in the Bid Schedule	F 949	N/A / 50 psi	12" to 36"
	ETI Ultra-Rib		F 794	N/A / 46 psi	12" to 48"
	Lamson Vylon		F 794	N/A / 46 psi	21" to 48"

* Allowed to be used where there are no service taps.
** Allowed to be used to a maximum depth of 10’ only.
***For water-sewer separation requirements unless specifically noted in Bid Schedule.

F When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM F 679, except provide wall thickness as required for SDR 26 and pipe strength of 115 psi.

G For Gravity Sanitary Sewers up to 12 inch diameter crossing over waterlines, or crossing under waterlines with less than 2 feet separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.

H Joints: Spigot and integral wall section bell with solid cross section elastometric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477, or ASTM D 3139 and ASTM F 477, shall be provided. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. The manufacturer shall test a sample from each batch conforming to requirements ASTM D 2444.

I Fittings: Provide PVC gravity sanitary sewer bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tees, wye fittings, or solvent welds are not acceptable.

2.03 HIGH DENSITY POLYETHYLENE (HDPE) SOLID AND PROFILE WALL PIPE

A Provide HDPE pipe as follows and only when listed as a Bid Item:

WALL TYPE	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	PIPE STIFFNESS (MIN)	DIAMETER RANGE (INCHES)
Solid Wall	Drisco 1000 Drisco 8600 Quail Pipe	Approved	F 714	115 psi	8 to 10

	Poly Pipe Plexco				

B Solid wall pipe shall be produced with plain end construction for heat-joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce a fused leak-free joint.

C Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D1248. Material meeting the requirements of cell classification in accordance with ASTM D 3350 is also suitable for making pipe products under these specifications.

D Gaskets:

1. Use gaskets meeting requirement of ASTM F 477. Use gasket molded into a circular form or extruded to the proper section and then spliced into circular form. When no contaminant is identified, use gaskets of a properly cured, high-grade elastomeric compound. The basic polymer shall be natural rubber, synthetic elastomer, or a blend of both.

E Lubricant. Use a lubricant for assembly of gasketed joints which has no detrimental effect on the gasket or on the pipe, in accordance with manufacturer's recommendations.

F Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.

2.04 CENTRIFUGALLY CAST FIBERGLASS PIPE

A Manufacturers

1. Pre-approved manufacturer for centrifugally cast fiberglass pipe is Hobas Pipe USA, Inc.

B Materials

1. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been collected from applications of a composite material of similar construction and composition as the proposed product.
2. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade glass filaments with binder and sizing compatible with impregnating resins.
3. Fillers: Silica sand or other suitable materials may be used.
4. Additives: Resin additives, such as pigments, dyes, and other coloring agents, if used, shall in no way be detrimental to the performance of the product nor shall they impair visual inspection of the finished products.
5. Rubber Gaskets: Supply from an approved gasket manufacturer in accordance with ASTM F 477, when no contaminant is identified and suitable for the service intended. Gaskets shall either be affixed to the pipe by means of a

suitable adhesive or shall be installed in such a manner so as to prevent the gasket from rolling out of the pre-cut groove in the pipe or sleeve coupling.

6. The internal liner resin shall be suitable for service as sewer pipe, and shall be highly resistant to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Pipe shall meet or exceed requirements of ASTM D 3681.

C Pipes

1. Furnish pipes in the diameters specified and within the tolerances specified below.
2. Manufacture pipe by the centrifugal casting process to result in a dense, nonporous, corrosion-resistant, consistent composite structure to meet the operating conditions as shown on the Plans.
3. Do not use stiffening ribs or rings.

D Couplings: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint watertightness. The joints must meet the performance requirements of ASTM D 4161.

E Fittings: Flanges, elbows, reducers, tees, and other fittings shall be capable of withstanding operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass fiber reinforced overlays.

F Manhole Connections: Provide a water stop flange (wall pipe) for connection to a cast-in-place manhole base or other structure.

G Grout Ports: Provide grout ports in the wall of pipe when required. Provide plugs of 316 stainless steel or other corrosion-resistant material compatible with the pipe. Grout port plugs shall be designed and installed to meet the test pressure of the pipe.

H Dimensions

1. Diameters: The actual outside diameter of the pipes shall be in accordance with Table 3 of ASTM D 3262 for Gravity Sanitary Sewers, or ASTM D 3754 for force mains.
2. Lengths: The pipe standard length will be approximately 20 feet. A maximum of 10 percent of the lengths, excluding special order pipes, may be supplied in random lengths.
3. Wall Thickness: The minimum average wall thickness shall be the stated design thickness. The minimum single point thickness shall not be less than 90 percent of the stated design thickness.
4. End Squareness: Pipe ends shall be square to the pipe axis.
5. Tolerance of Fittings: The tolerance of the angle of an elbow and the angle between the main and leg of a wye or tee shall be plus or minus 2 degrees. The tolerance on the laying length of a fitting shall be plus or minus 2 inches.

I Stiffness Classes

1. Stiffness class of FRP pipe shall satisfy design requirements, but shall not be less than 46 psi, when used in direct bury operation; 36 psi, when installed within a primary tunnel liner.
2. Stiffness class of FRP in a pipe jacking operation shall be governed either by the ring deflection limitations or by a pipe design providing longitudinal strength required by the jacking method and shall satisfy design requirements stated below. Submit design calculations as required in Paragraph 1.05, Submittals.
    a. Pipe stress calculations based on jacking loads shall be provided by the pipe supplier.
    b. Ring deflection calculations shall conform to design requirements of 30 TAC Chapter 317.20 pertaining to flexible pipe used in Gravity Sanitary Sewers. The pipe deflection calculations shall ensure that predicted deflection will be less than 5 percent under long-term loading conditions (soil prism load) for the highest density of soil overburden and surcharge loads. Deflection on calculations shall be prepared using long-term (drained) values for soil parameters contained in the geotechnical investigation report for the Project, or other site-specific data obtained by the Contractor as approved by the Engineer.

J Testing
1. Pipes shall be tested in accordance with ASTM D 3262 or ASTM D 3754, as applicable, except that the factory hydrostatic pressure testing is not required.
2. Joints: Coupling joints shall be qualified per the tests of Section 7 of ASTM D 4161.

K Packaging, Handling, and Shipping
1. Packing, handling, and shipping should be done in accordance with the manufacturer's recommendations.

L Installation
1. Install pipe and fittings in accordance with requirements of this Section.
2. The manufacturer must supply a suitable qualified field service representative to be present periodically during the installation of pipe.
3. Pipe Bedding: Conform to requirements of Section 02318 – Excavation and Backfill for Utilities.
4. Pipe Handling: Use textile slings.
5. Jointing
    a. Clean ends of pipe and coupling components.
    b. Check pipe ends and couplings for damage. Correct any damage found.
    c. Coupling grooves must be completely free of dirt.
    d. Apply joint lubricant to pipe ends and rubber seals of coupling. Use only lubricants approved by the pipe manufacturer.
    e. Use suitable auxiliary equipment, such as a wire rope puller, to pull joints together.

f. Do not exceed forces recommended by the manufacturer for coupling pipe. If excessive force is required, remove coupling, determine source of problem, and correct it.

g. In the process of jointing the pipe, do not allow the deflection angle to exceed the deflection permitted by the manufacturer.

6. If pressure grouting of the pipe is conducted as part of a pipe-jacked tunnel installation, seal the grout holes with liner resin to a thickness equal to the pipe liner thickness, or with a threaded plug for that purpose.

7. Tests: Conform to requirements of this Section.

2.05 INSPECTIONS

A The Engineer reserves the right to inspect pipes or witness pipe manufacturing. Such inspection shall in no way relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications.

B Manufacturer's Notification to Customer. Should the Engineer wish to witness the manufacture of specific pipes, the manufacturer shall provide the Engineer with adequate advance notice of when and where the production of those specific pipes will take place.

C Failure to Inspect. Approval of the products or tests is not implied by the Engineer’s decision not to inspect the manufacturing, testing, or finished pipes.

2.06 TEST METHODS

A Conditioning. Conditioning of samples prior to and during tests is subject to approval by the Engineer. When referee tests are required, condition the specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F (23 degrees C plus or minus 2 degrees C) and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under the same conditions of temperature and humidity unless otherwise specified.

B Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.05A, in a suitable press until the internal diameter has been reduced to 40 percent of the original inside diameter of the pipe. The rate of loading shall be uniform and at 2-inches per minute. The test specimens, when examined under normal light and with the unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of the pipe walls or bracing profiles.

C Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace the shear load transfer bars and supports with 6 inch wide support blocks that can be either flat or contoured to conform to the pipe's outer contour.

D Purpose of Tests. The flattening and the joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

2.07 MARKING

A Mark each standard and random length of pipe in compliance with these Specifications with the following information:
1. Pipe size
2. Pipe class
3. Production code
4. Material designation

3.0 EXECUTION

3.01 PREPARATION

A Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety Systems.

B Install and operate dewatering and surface water control measures in accordance with Section 01564 - Control of Ground Water and Surface Water.

C Remove existing pavements and structures, including sidewalks and driveways, in conformance with requirements of Section 02220 – Site Demolition, as applicable.

3.02 DIVERSION PUMPING

A Install and operate required bulkheads, plugs, piping, and diversion pumping equipment to maintain sewage flow and to prevent backup or overflow. Obtain approval for diversion pumping equipment and procedures from the Engineer.

B Design piping, joints and accessories to withstand twice the maximum system pressure or 50 psi, whichever is greater.

C No sewage shall be diverted into any area outside of the sanitary sewer.

D In the event of accidental spill or overflow, immediately stop the overflow and take action to clean up and disinfect spillage. Promptly notify the Engineer so that required reporting can be made to the TCEQ and the Environmental Protection Agency by the Engineer.

3.03 INSPECTION AND TESTING

A Acceptance testing of sanitary sewers including:
1. Visual inspection of sewer pipes
2. Mandrel testing for flexible sewer pipes.
3. Leakage testing of sewer pipes.
4. Leakage testing of manholes.

B Performance Requirements:
1. Gravity sanitary sewers are required to have a straight alignment and uniform grade between manholes.

2. Flexible pipe, including "semi-rigid" pipe, is required to show no more than 5 percent deflection. Test pipe no sooner than 30 days after backfilling of a line segment but prior to final acceptance using a standard mandrel to verify that installed pipe is within specified deflection tolerances.
3. Maximum allowable leakage for Infiltration or Exfiltration
   a. The total exfiltration, as determined by a hydrostatic head test, shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours at a minimum test head of 2 feet above the crown of the pipe at the upstream manhole or 2 feet above the groundwater elevation, whichever is greater.
   b. When pipes are installed more than 2 feet below the groundwater level, an infiltration test shall be used in lieu of the exfiltration test. The total infiltration shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours. Groundwater elevation must be at least 2 feet above the crown of the pipe at the upstream manhole.
   c. Refer to Table 2530-1, Water Test Allowable Leakage, at the end of the Section, for measuring leakage in sewers. Perform leakage testing to verify that leakage criteria are met.
4. Perform air testing in accordance with requirements of this Section and the Texas Natural Resources Conservation Commission requirements. Refer to Table 02530-2, Time Allowed For Pressure Loss From 3.5 psig to 2.5 psig, Table 02530-3, Minimum Testing Times for Low Pressure Air Test, and Table 02530-4, Vacuum Test Time Table, at the end of this Section.

C Gravity Sanitary Sewer Quality Assurance:
1. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.
2. Provide testing reports and video tape of television inspection as directed by Engineer.
3. Upon completion of tape reviews by Engineer, Contractor will be notified regarding final acceptance of the sewer segment.

D Sequencing and Scheduling:
1. Perform testing as work progresses. Schedule testing so that no more than 1000 linear feet of installed sewer remains untested at any one time.
2. Coordinate testing schedules with Engineer. Perform testing under observation of Engineer.

E Deflection Mandrel:
1. Mandrel Sizing. The rigid mandrel shall have an outside diameter (O.D.) equal to 95 percent of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe, dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
2. Mandrel Design. The rigid mandrel shall be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed. The

mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75 percent of the inside diameter of the pipe. The rigid mandrel shall not have adjustable or collapsible legs which would allow a reduction in mandrel diameter during testing. A proving ring shall be provided and used for modifying each size mandrel.

3. Proving Ring. Furnish a "proving ring" with each mandrel. Fabricate the ring of 1/2 inch thick, 3-inch-wide bar steel to a diameter 0.02 inches larger than approved mandrel diameter.
4. Mandrel Dimensions (5 percent allowance). Average inside diameter and minimum mandrel diameter are specified in Table 02530-5, Pipe vs. Mandrel Diameter, at the end of this Section. Mandrels for higher strength, thicker wall pipe or other pipe not listed in the table may be used when approved by the Engineer.

F Exfiltration Test:

1. Water Meter: Obtain a transient water meter from the City for use when water for testing will be taken from the City system. Conform to City requirements for water meter use.
2. Test Equipment:
   a. Pipe plugs.
   b. Pipe risers where the manhole cone is less than 2 feet above highest point in pipe or service lead.

G Infiltration Test:

1. Test Equipment:
   a. Calibrated 90 degree V-notch weir.
   b. Pipe plugs.

H Low Pressure Air Test:

1. Minimum Requirement for Equipment:
   a. Control panel.
   b. Low-pressure air supply connected to control panel.
   c. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.
   d. Air hoses from control panel to:
      1) Air supply.
      2) Pneumatic plugs.
      3) Sealed line for pressuring.
      4) Sealed line for monitoring internal pressure.
2. Testing Pneumatic Plugs: Place a pneumatic plug in each end of a length of pipe on the ground. Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig. Plugs are acceptable if they remain in place against the test pressure without external aids.

I Ground Water Determination:

1. Equipment: Pipe probe or small diameter casing for ground water elevation determination.

J Visual Inspection:

1. Check pipe alignment visually by flashing a light between structures. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and re-lay or replace pipe segment.

K Mandrel Testing:

1. Perform deflection testing on flexible and semi-rigid pipe to confirm pipe has no more than 5 percent deflection. Mandrel testing shall conform to ASTM D 3034. Perform testing no sooner than 30 days after backfilling of line segment, but prior to final acceptance testing of the line segment.
2. Pull the approved mandrel by hand through sewer sections. Replace any section of sewer not passing the mandrel. Mandrel testing is not required for stubs.
3. Retest repaired or replaced sewer sections.

L Leakage Testing:

1. Test Options:
   a. Test Gravity Sanitary Sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.
   b. Test new or rehabilitated sanitary sewer manholes with water or low pressure air. Manholes tested with low pressure air shall undergo a physical inspection prior to testing.
   c. Leakage testing shall be performed after backfilling of a line segment, and prior to tie-in of service connections.
   d. If no installed piezometer is within 500 feet of the sewer segment, Contractor shall provide a temporary piezometer for this purpose.
2. Compensating for Ground Water Pressure:
   a. Where ground water exists, install a pipe nipple at the same time sewer line is placed. Use a 1/2-inch capped pipe nipple approximately 10 inches long. Make the installation through manhole wall on top of the sewer line where line enters manhole.
   b. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect a clear plastic tube to nipple. Support tube vertically and allow water to rise in the tube. After water stops rising, measure height in feet of water over invert of the pipe. Divide this height by 2.3 feet/psi to determine the ground water pressure to be used in line testing.
3. Exfiltration test:
   a. Determine ground water elevation.
   b. Plug sewer in downstream manhole.
   c. Plug incoming pipes in upstream manhole.
   d. Install riser pipe in outgoing pipe of upstream manhole if highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.

e. Fill sewer pipe and manhole or pipe riser, if used, with water to a point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.

f. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over a one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure the quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to Table 02530-1 at the end of this Section.

4. Infiltration test: Ground water elevation must be not less than 2.0 feet above highest point of sewer pipe or service lead (house service).

a. Determine ground water elevation.

b. Plug incoming pipes in upstream manhole.

c. Insert calibrated 90 degree V-notch weir in pipe on downstream manhole.

d. Allow water to rise and flow over weir until it stabilizes.

e. Take five readings of accumulated volume over a period of 2 hours and use average for infiltration. The average must not exceed that calculated for 2 hours from allowable leakage according to the Table 02530-1 at the end of this Section.

5. Low Air Pressure Test: When using this test conform to ASTM C 828, ASTM C 924, or ASTM F 1417, as applicable, with holding time not less than that listed in Table 02530-2.

a. Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter.

b. Lines 36-inch average inside diameter and larger shall be tested at each joint. The minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch during a joint test shall be 10 seconds, regardless of pipe size.

c. For pipe sections less than 36-inch average inside diameter:

1) Determine ground water level.

2) Plug both ends of pipe. For concrete pipe, flood pipe and allow 2 hours to saturate concrete. Then drain and plug concrete pipe.

3) After a manhole-to-manhole section of sanitary sewer main has been sliplined and prior to any service lines being connected to new liner, plug liner at each manhole with pneumatic plugs.

4) Pressurize pipe to 4.0 psig. Increase pressure 1.0 psi for each 2.3 feet of ground water over highest point in system. Allow pressure to stabilize for 2 to 4 minutes. Adjust pressure to start at 3.5 psig (plus adjustment for ground water table). Refer to Table 02530-2 at the end of this Section.

5) To determine air loss, measure the time interval for pressure to drop to 2.5 psig. The time must exceed that

listed in the Table 02530-2 at the end of this Section for pipe diameter and length. For sliplining, use diameter of carrier pipe.

6. Retest: Any section of pipe which fails to meet requirements shall be repaired and retested.

M Test Criteria Tables

1. Exfiltration and Infiltration Water Tests: Refer to Table 02530-1, Water Test Allowable Leakage, at the end of this Section.
2. Low Pressure Air Test:
   a. Times in Table 02530-2, Time Allowed For Pressure Loss From 3.5 psig to 2.5 psig, at the end of this Section, are based on the equation from TCEQ Design Criteria for Sewerage Systems: 317.2(a)(4)(B).

$$T = 0.0850(D)(K)/(Q)$$

Where:

T	=	Time for pressure to drop 1.0 pounds per square inch gauge in seconds
K	=	0.000419 DL, but not less than 1.0
D	=	Average inside diameter in inches
L	=	Length of line of same pipe size in feet
Q	=	Rate of loss, 0.0015 ft^3/min./sq. ft. internal surface

   b. Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as given in Table 02732-3, Minimum Testing Times for Low Pressure Air Test.

Notes:
1. When two sizes of pipe are involved, the time shall be computed by the ratio of lengths involved.
2. Line with a 27-inch average inside diameter and larger may be air tested at each joint.
3. Lines with an average inside diameter greater than 36 inches must be air tested for leakage at each joint
4. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing.
5. For joint test, the pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum times allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

N Leakage Testing for Manholes

1. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.
2. Plug influent and effluent lines, including service lines, with suitably-sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendations. Place plugs a minimum of 6 inches outside of manhole walls. Brace inverts to prevent lines from being dislodged if lines entering manhole have not been backfilled.
3. Vacuum testing:
    a. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to the recommended maximum inflation pressure; do not over-inflate.
    b. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for the time period specified in Table 02530-4, Vacuum Test Time Table.
    c. If the drop in vacuum exceeds 1 inch Hg over the specified time period tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.
4. Hydrostatic exfiltration testing shall be performed as follows:
    a. Seal wastewater lines coming into the manhole with an internal pipe plug. Then fill the manhole with water and maintain it full for at least one hour.
    b. The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour.
    c. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

3.04 BACKFILL

A Backfill and compact soil in accordance with Section 02318 – Excavation and Backfill for Utilities.

B Backfill the trench in specified lifts only after pipe installation is approved by the Engineer.

3.05 CLEAN UP AND RESTORATION

A Perform clean up and restoration in and around construction zone in accordance with Section 01140 - Contractor’s Use of Premises.

3.06 PROTECTION OF THE WORK

A Maintain gravity sanitary sewer installations in good condition until completion of the work.

Table 02530-1
WATER TEST ALLOWABLE LEAKAGE

DIAMETER OF RISER OR STACK IN INCHES	VOLUME PER INCH OF DEPTH		ALLOWANCE LEAKAGE*	
	INCH	GALLONS	PIPE SIZE IN INCHES	GALLONS/MINUTE PER 100 FT.
1	0.7854	.0034	6	0.0039
2	3.1416	.0136	8	0.0053
2.5	4.9087	.0212	10	0.0066
3	7.0686	.0306	12	0.0079
4	12.5664	.0306	15	0.0099
5	19.6350	.0544	18	0.0118
6	28.2743	.1224	21	0.0138
8	50.2655	.2176	24	0.0518
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value for 1” diameter			Equivalent to 50 gallons per inch inside diameter per mile per 24 hours	

* Allowable leakage rate shall be reduced to 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within the 25-year flood plain.

Table 02530-2
ACCEPTANCE TESTING FOR SANITARY SEWERS

TIME ALLOWED FOR PRESSURE LOSS FROM 3.5 PSIG TO 2.5 PSIG														
Pipe Diam (in)	Min. Time (min:sec)	Length for Min. Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)										
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft	550 ft	600 ft
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40	13:36	15:12
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.3690	35:37	53:37	71:14	89:02	106:51	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.8565	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28	237:01	258:34

Table 02530-3
MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST

PIPE DIAMETER (INCHES)	MINIMUM TIME (SECONDS)	LENGTH FOR MINIMUM TIME (FEET)	TIME FOR LONGER LENGTH (SECONDS)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)
24	1360	100	13.676 (L)
27	1530	88	17.309 (L)
30	1700	80	21.369 (L)
33	1870	72	25.856 (L)

Table 02530-4
VACUUM TEST TIME TABLE

DEPTH IN FEET	TIME IN SECONDS BY PIPE DIAMETER		
	48"	**60"**	**72"**
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0

*Add T times for each additional 2-foot depth.
(The values listed above have been extrapolated from ASTM C 924-85)

Table 02530-5
PIPE VS. MANDREL DIAMETER

MATERIAL AND WALL CONSTRUCTION	NOMINAL SIZE (INCHES)	AVERAGE I.D. (INCHES)	MINIMUM MANDREL DIAMETER (INCHES)
PVC-Solid (SDR 26)	6	5.764	5.476
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35)	12	11.737	11.150
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
PVC-Profile (ASTM F 794)	12	11.740	11.153
	15	14.370	13.652
	18	17.650	16.768
	21	20.750	19.713
	24	23.500	22.325
	27	26.500	25.175
	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
	48	47.500	45.125
HDPE-Profile	18	18.000	17.100
	21	21.000	19.950
	24	24.000	22.800
	27	27.000	25.650
	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600
	54	54.000	51.300
	60	60.000	57.000
Fiberglass-Centrifugally Cast (Class SN 46)	12	12.85	11.822
	18	18.66	17.727
	20	20.68	19.646
	24	24.72	23.484
	30	30.68	29.146
	36	36.74	34.903
	42	42.70	40.565
	48	48.76	46.322
	54	54.82	52.079
	60	60.38	57.361

END OF SECTION

Section 02531

SANITARY SEWER SERVICE LEADS OR RECONNECTIONS

1.0 GENERAL

1.01 SECTION INCLUDES

A Installation of service stubs on new sanitary sewers serving areas where sanitary sewer service did not previously exist.

B Reconnection of existing service connections along parallel, replacement, or rehabilitated sanitary sewers.

C References to Technical Specifications:
1. Section 01350 – Submittals
2. Section 01760 – Project Record Documents
3. Section 01500 – Temporary Facilities and Controls
4. Section 01570 – Trench Safety System
5. Section 01564 – Control of Ground Water and Surface Water
6. Section 02318 – Excavation and Backfill for Utilities
7. Section 02530 – Gravity Sanitary Sewers
8. Section 01140 – Contractor's Use of Premises

D Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 1784, "Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds"
   b. ASTM D 3034, "Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings"
   c. ASTM D 3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals"

1.02 MEASUREMENT AND PAYMENT

A Measurement for single, near-side service leads is on a per each basis, complete in place.

B Measurement for double, near-side service leads is on a per each basis, completed in place.

C Measurement for single, far-side service leads is on a per each basis, complete in place.

D Measurement for double, far-side service leads is on a per each basis, complete in place.

E Payment for service leads includes service connections, couplings, clean-outs, adapters, disconnecting existing services, reconnecting new service, fittings, excavation, backfill, and testing.

F Measurement for sanitary sewer stacks up to 3 vertical feet is on a per each basis, complete in place. Payment includes riser pipe, service connections, couplings, clean-outs, adapters, disconnecting existing services, reconnecting new service, fittings, excavation, backfill, and testing.

G Measurement for extra depth sanitary sewer stacks greater than 3 vertical feet is on a vertical foot basis from the top of the receiving sewer to the invert of the service connection, measured and complete in place. Payment includes excavation, pipe, bedding, and backfill for that portion of the stack in excess of 3 feet.

H Measurement for sanitary sewer service reconnections with stacks located within 5 feet of the sanitary sewer main centerline shall be per each reconnection, complete in place.

I Measurement for sanitary sewer service reconnections without stacks located within 5 feet of the sanitary sewer main centerline shall be per each reconnection, complete in place.

J Payment for sanitary sewer service reconnections includes include service connections, couplings, clean-outs, adapters disconnecting existing services, reconnecting new service, fittings, excavation, backfill, and testing.

K Augered pipe for service leads will be paid as provided in Section 02415 – Augering Pipe or Casing for Sewer.

L One or more connections discharging into a common point are considered one service connection. The Contractor shall not add service reconnections without approval of the Engineer. The Engineer may require reconnections to be moved or relocated to avoid having more than two single family units per reconnection.

M Measurement for abandonment of service connection is on a per each basis. No additional payment will be made for abandonment of service connection unless excavation is required beyond new or replacement sewer or service lead trench zone. No separate payment will be made for excavation of sanitary sewer services within the new or replacement sewer trench.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit product data for each pipe product, fitting, coupling and adapter.

C Submit field red lines documenting location of sanitary sewer stubs and reconnections as installed, referenced to survey Control Points, under the provisions of Section 01760

– Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients. Record the exact distance from each service connection to the nearest downstream manhole.

1.04 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 PVC SERVICE CONNECTION

A As stubouts, use PVC sewer pipe, 4-inch through 10-inch, conforming to ASTM D 1784 and ASTM D 3034, with a cell classification of 12454-B. The SDR (ratio of diameter to wall thickness) shall be 26 for pipe 10 inches in diameter or less.

B PVC pipe shall be gasket jointed with gasket conforming to ASTM D3212.

C Provide service connection pipe in sizes shown on the Plans. For reconnection of existing services, select service connection pipe diameter to match existing service diameter.

D Provide a 6-inch service connection when more than one service discharges into a single pipe.

E Connect service pipes to new parallel or replacement sewer mains with prefabricated, full-bodied tee or wye fittings conforming to specifications for the sewer main pipe material as specified in other Sections for all sewers up to 18 inches in diameter.

F Where new sewers are installed using pipe augering or tunneling, or where the new sewer is greater than 18 inches in diameter, use Fowler “Inserta-Tee” to connect the service to the new sewer main.

2.02 PIPE SADDLES

A Use pipe saddles only on rehabilitated sanitary sewer mains. Comply with Paragraph 2.01E for new parallel and replacement sanitary sewer mains.

2.03 COUPLINGS AND ADAPTERS

A For connection between new PVC pipe stubout and existing service; 4-, 6-, or 8-inch diameter, use flexible adapter coupling consisting of a neoprene gasket and stainless steel shear ring, with 1/2-inch stainless steel band clamps:
1. Fernco Pipe Connectors, Inc., Series 1055 with shear ring SR-8;
2. Band Seal by Mission Rubber Co., Inc.;
3. Approved equal.

B For connection between new PVC pipe stub out and new service, use rubber-gasketed adapter coupling:
1. GPK Products, Inc., IPS & Sewer Adapter.
2. Approved Equal.

2.04 STACKS

A Provide stacks for service connections wherever the crown of the sewer is 8 feet or more below finished grade.

B Construct stacks of the same material as the sanitary sewer and as shown on the Plans.

C Provide stacks of the same nominal diameter at the sanitary service line.

2.05 CLEAN-OUTS

A Install clean-outs at property line on each service connection as shown in detail on the Plans.

2.06 PLUGS AND CAPS

A Seal the upstream end of unconnected sewer service stubs with rubber gasketed plugs or caps of the same pipe type and size. Provide plugs or caps by GPK Products, Inc., or equal.

3.0 EXECUTION

3.01 PERFORMANCE REQUIREMENTS

A Accurately field locate service connections, whether in service or not, as pipe laying progresses from downstream to upstream.

B Properly disconnect existing connections from the sewer and reconnect to the new sewer, as described in this Section.

C Reconnect service connections, including those that go to unoccupied or abandoned buildings, unless directed otherwise by the Engineer. Plug the service connection at the R.O.W. for vacant lots.

D Connect services 8 inches in diameter and larger to the sewer by construction of a manhole.

3.02 PREPARATION

A Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety System.

B Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.

C Provide a minimum of 48 hours notice to customers whose sanitary sewer service will potentially be interrupted.

D Schedule Work so that reconnection of service lines can be completed within 24 hours after disconnection.

E Where sewers are existing, field locate existing service connections, whether in service or not. Use existing service locations for reconnection of service lines to new liner or new sanitary sewer main.

F For new parallel and replacement sanitary sewer mains, complete testing and acceptance of downstream sewers as applicable.

3.03 EXCAVATION AND BACKFILL

A Excavate and backfill in accordance with Section 02318 – Excavation and Backfill for Utilities.

3.04 RECONNECTION ON NEW SEWER

A Install the new service connection on the new sanitary sewer main for each service connection.

B Remove and replace cracked, offset or leaking service line for up to 5 feet, measured horizontally, from the centerline of the new sanitary sewer main.

C Make up the connection between the new main and the existing service line using PVC sewer pipe and approved couplings, as shown on the Plans.

D Test service connections before backfilling.

E Embed the service connection and service line as specified for the new sanitary sewer main at this location, and as shown on the Plans. Place and compact trench zone backfill in compliance with Section 02318 – Excavation and Backfill for Utilities.

3.05 INSTALLATION OF NEW SERVICE LEADS

A Install the new service connections on the new sanitary sewer main for each service connection. Provide the length of stub indicated on the Plans. Install plug or cap on the upstream end of the service stub as needed.

B Test service connections before backfilling.

C Embed the service connection and service line as specified for the new sanitary sewer main at this location, and as shown on the Plans. Place and compact trench zone backfill in compliance with Section 02318 – Excavation and Backfill for Utilities.

3.06 FIELD QUALITY CONTROL

A Test service reconnections and service stubs. Follow applicable procedures given in Section 02530 – Gravity Sanitary Sewers.

3.07 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

3.08 PROTECTION OF THE WORK

A Protect and maintain all installations good condition until completion of Work.

B Replace installations by Contractor's operations at no cost to Owner.

C Do not allow sand, debris or runoff to enter sewer system.

END OF SECTION

Section 02532

HIGH DENSITY POLYETHYLENE (HDPE) SOLID WALL PIPE

1.0 GENERAL

1.01 SECTION INCLUDES

A High Density Polyethylene (HDPE) pipe for gravity sewers and drains, including fittings.

B HDPE pipe for sanitary sewer force mains, including fittings.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 02630 – Storm Sewers
4. Section 02530 – Gravity Sanitary Sewers

D Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM F 714, "Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter"
   b. ASTM D 2657, "Standard Practice for Heat Fusion Joining and Polyolefin Pipe and Fittings"
   c. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"
   d. ASTM D 350, "Standard Test Method for Flexible Treated Sleeving Used for Electrical Insulation"
   e. ASTM F 477, "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe"
   f. ASTM D 618, "Standard Practice for Conditioning Plastics for Testing"
   g. ASTM D 3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals"

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for HDPE pipe under this Section. Include cost in Bid Items for gravity sanitary sewers and storm sewers.

B If HDPE pipe is included as a Bid Item, measurement will be based on the units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit Shop Drawings showing design of pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

C Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 PRODUCT QUALITY CONTROL

A Provide the manufacturer's certificate of conformance to the Technical Specifications.

2.0 PRODUCTS

2.01 APPROVED AND PREAPPROVED PRODUCTS

A Provide HDPE pipe as follows:

WALL TYPR	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	PIPE STIFFNESS (MIN)	DIAMETER RANGE (INCHES)
Solid Wall	Drisco 1000 Drisco 8600 Quail Pipe Poly Pipe Plexco	Approved	F 714	115 psi	8 to 10
				46 psi	12 to 48

B Solid wall pipe shall be produced with plain end construction for heat-joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce a fused leak-free joint.

2.02 MATERIALS

A Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Material meeting the requirements of cell classification in accordance with ASTM D 350 are also suitable for making pipe products under these specifications.

B Gaskets

1. Use gaskets meeting requirement of ASTM F 477. Use gasket molded into a circular form or extruded to the proper section and then spliced into circular form. When no contaminant is identified, use gaskets of a properly cured, high-grade elastomeric compound. The basic polymer shall be natural rubber, synthetic elastomer, or a blend of both.

2. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following gasket materials for the noted contaminants:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by the pipe manufacturer

C Lubricant. Use a lubricant for assembly of gasketed joints which has no detrimental effect on the gasket or on the pipe, in accordance with manufacturer's recommendations.

2.03 WORKMANSHIP

A Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.

2.04 INSPECTIONS

A The Engineer reserves the right to inspect pipes or witness pipe manufacturing. Such inspection shall in no way relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications.

B Manufacturer's Notification to Customer. Should the Engineer wish to witness the manufacture of specific pipes, the manufacturer shall provide the Engineer with adequate advance notice of when and where the production of those specific pipes will take place.

C Failure to Inspect. Approval of the products or tests is not implied by the Engineer’s decision not to inspect the manufacturing, testing, or finished pipes.

2.05 TEST METHODS

A Conditioning: Conditioning of samples prior to and during tests are subject to approval by the Engineer. When referee tests are required, condition the specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F (23 degrees C plus or minus 2 degrees C) and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under the same conditions of temperature and humidity unless otherwise specified.

B Flattening: Flatten three specimens of pipe, prepared in accordance with Paragraph 2.05A, in a suitable press until the internal diameter has been reduced to 40 percent of the original inside diameter of the pipe. The rate of loading shall be uniform and at 2-inches per minute. The test specimens, when examined under normal light and with

the unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of the pipe walls or bracing profiles.

C Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace the shear load transfer bars and supports with 6-inch-wide support blocks that can be either flat or contoured to conform to the pipe's outer contour.

D Purpose of Tests. The flattening and the joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

2.06 MARKING

A Mark each standard and random length of pipe meeting the requirements of this Section with the following information:

1. Pipe size
2. Pipe class
3. Production code
4. Material designation

3.0 EXECUTION

3.01 INSTALLATION

A Conform to requirements of the following Sections:

1. Section 02630 – Storm Sewers
2. Section 02530 – Gravity Sanitary Sewers

B All HDPE installations shall be bedded and backfilled to top or pipe zone with cement stabilized sand.

C All HDPE pipe must terminate in manholes, concrete headwalls, or safety and treatment structures.

D Install pipe in accordance with the manufacturer’s recommended installation procedures.

END OF SECTION

Section 02532W

HIGH DENSITY POLYETHYLENE (HDPE) SOLID WALL PIPE FOR WATER

1.00 GENERAL

1.01 SECTION INCLUDES

A. Furnish labor, materials, equipment and incidentals necessary to install polyethylene pipe, and complete installation in accordance with the Contract Documents. The finished pipe shall be continuous over the entire length of the water line between fittings and be free from defects.

B. Domestic water piping shall be approved by the Underwriters Laboratory and shall be accepted by the State Fire Insurance Commission for use in water distribution systems. HDPE water pipe shall bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

C. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 02510 – Water Mains

D. Standards: Comply with local governing regulations if more stringent than specified herein. Piping shall meet the following standards and shall be a part of this Section as if written here in their entirety.

1. American Society for Testing and Materials (ASTM) Standards:
   a. ASTM F1473, Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
   b. ASTM D2122, Determining Dimensions of Thermoplastic Pipe and Fittings
   c. ASTM F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
   d. ASTM D2837, Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
   e. ASTM D3035, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter (up to 3-Inch IPS)
   f. ASTM D3350, Specification for Polyethylene Plastics Pipe and Fittings Material
   g. ASTM F714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter (4-Inch IPS and larger)
2. American Water Works Association (AWWA) Standards:
   a. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 through 64 Inches, for Water Distribution
   b. AWWA M55, Polyethylene (PE) Pipe Design and Installation

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for HDPE pipe under this Section. Include cost in Bid Items for water mains.

B. If HDPE pipe is included as a Bid Item, measurement will be based on the units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit Shop Drawings showing design of pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

C. Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 QUALITY ASSURANCE

A. Polyethylene pipe jointing shall be performed by personnel trained in the use of the thermal butt-fusion equipment and recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall have received training in the proper methods for handling and installing the polyethylene pipe. Training shall be performed by a qualified representative of the pipe manufacturer. The Contractor shall maintain records of trained personnel, and shall certify that training was received not more than 12 months before commencing construction.

1.05 DELIVERY AND STORAGE

A. Transport, handle, and store pipe and fittings as recommended by manufacturer.

B. If new pipe and fittings become damaged before or during installation, it shall be repaired as recommended by the manufacturer or replaced as required by the Owner's Project Representative at the Contractor's expense, before proceeding further.

C. Deliver, store, and handle other materials as required to prevent damage.

2.00 PRODUCTS

2.01 MATERIALS

A. Pipe: Polyethylene Plastic Pipe shall be high density polyethylene pipe (HDPE).

1. Solid wall high density polyethylene for pressure water pipe shall meet the requirements of AWWA C906 "Polyethylene (PE) Pressure Pipe and Fittings, 4 through 64 Inches, for Water Distribution" (Ductile Iron Pipe Sizing).

B. All pipe shall be made of virgin material. No rework except that obtained from the manufacturer's own production of the same formulation shall be used.

1. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
2. Dimension Ratios: The minimum wall thickness of the polyethylene pipe shall meet the following:
   a. Pressure Applications: AWWA C906 DR-11 Pressure Class 160.
3. All HDPE shall be carbon black or solid gray stabilized throughout the structural wall for ultra-violet protection. The pipe shall have a near white inside diameter to facilitate future TV inspection.

C. Bends and Fittings: ANSI A21.10, ductile iron; ANSI A21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating.

D. Coatings and Linings: Conform to requirements of Section 02634 – Ductile Iron Pipe and Fittings.

2.02 MATERIALS TEST

A. Tests for compliance with this Section shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate of compliance with ISO 9000 shall be furnished, by the manufacturer for all material furnished under this Section. Polyethylene plastic pipe and fittings may be rejected for failure to meet any of the requirements of this Section.

3.00 EXECUTION

3.01 HANDLING

A. The joints shall be handled near the middle with wide web slings and spreader bars. Rope slings also work well with straight lengths. The use of chains, end hooks or cable slings that may scar the pipe are not permitted. The following procedures shall be observed when handling HDPE pipe.

1. Always stack the heaviest series of pipe at the bottom.
2. Protect the pipe from sharp edges when overhanging the bed of a truck or trailer by placing a smooth, rounded protecting strip on the edge of the bed.
3. The load should be anchored securely to prevent slippage.

B. Lengths of small-diameter, lightweight pipe can be unloaded manually.

C. Pipe applications shall normally be handled by:

1. Unloading the pipe from the truck in a row along the side of the installation area and moving the fusion unit along the row of joints.
2. Stacking the pipe beside the fusion unit and trailing the pipe out after fusion, then dragging the long length of pipe into place for installation. It is suggested that as the pipe is fused and moved through the fusion machine, additional joints of pipe should be placed in the moveable jaw side of the machine for

each subsequent fusion. This prevents the hydraulic system of the machine from having to pull the previously fused long length.

D. Dragging the pipe into place is permitted provided the pipe isn't damaged from sharp rocks or excessive abrasion created by pulling the pipe great distances.

3.02 PIPE JOINING

A. The polyethylene pipe shall be assembled and joined at the Site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment.

B. The butt-fused joint shall be in true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. When cool, all weld beads shall then be removed from the inside surface such that the joint surfaces shall be smooth. The fused joint shall be watertight and shall have a tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the Owner's Project Representative. All defective joints shall be cut out and replaced at no cost to the Owner. Any section of the pipe with a gash, blister, abrasion, nick, scar or other deleterious fault greater in depth than 10 percent of the wall thickness, shall not be used and must be removed from the Site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the Owner's Project Representative shall be discarded and not used.

3.03 BENDING PIPE

A. HDPE may be cold-bent to a minimum radius of 40 times the pipe diameter as it is installed, eliminating the need in many cases for elbows for slight bends. The minimum bending radius that can be applied to the pipe without kinking varies with the diameter and wall thickness of the pipe. Contractor shall conform to manufacturer's recommendations. If adequate space is not available for the required radius, a fitting of the desired angle shall be fused into the piping system to obtain the necessary change in direction.

3.04 INSTALLATION BELOW GROUND

A. Conform to requirements of Section 02510 – Water Mains.

B. Pipe Laying:

1. When pulling pipe, either a pulling head or a suitable wraparound sleeve with rubber protective cover shall be used to prevent the pulling cables from damaging the pipe. The pipe shall not be pulled by the flanged end.
2. Install pipe in accordance with Section 02318 – Excavation and Backfill for Utilities, and manufacturer's recommendations.

3.05 FIELD QUALITY CONTROL

A. Testing shall be as specified in Section 01450 - Testing Laboratory Services.

B. Hydrostatic Testing for pressure piping systems shall be performed in accordance with ASTM F2164. Testing pressure shall not exceed 1.5 times the system design pressure and total testing time including the time required to pressurize, stabilize, hold test pressure, and depressurize should not exceed 8 hours. If 5 psi is lost during testing pipeline must be re-pressurized.

C. HDPE pipe deflection shall not exceed deflection percentages identified in ASTM F1962 or manufacturer’s maximum allowable deflection, whichever is lower. Allowable pipe deflection varies based on DR rating. The following maximum deflection percentages can be used for the following DR ratings: DR21 – 7.5 percent, DR17 – 6.0 percent, DR15.5 – 6.0 percent, DR13.5 – 6.0 percent, DR11 – 5.0 percent, DR9 – 4.0 percent, DR7.3 – 3.0 percent. Deflection measurements can be taken by mandrel or by measurement of inside diameter before and after backfill operations.

D. Do not enclose or cover any Work until inspected.

3.06 CLEAN AND ADJUST

A. Remove surplus pipeline materials, tools, rubbish and temporary structures and leave the construction site clean, to the satisfaction of the Owner’s Project Representative.

END OF SECTION

Section 02533

SANITARY SEWAGE FORCE MAINS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewage force mains.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 02634 – Ductile Iron Pipe and Fittings
5. Section 03300 – Cast-in-Place Concrete
6. Section 02318 – Excavation and Backfill for Utilities

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

   a. ASTM F 477, "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe"
   b. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"

2. American Concrete Institute (ACI)

1.02 MEASUREMENT AND PAYMENT

A. Measurement for pipe is on a linear foot basis taken along the center line of the pipe from end to end, measured and complete in place.

B. Payment for sanitary sewage force mains includes pipe, fittings, excavation, bedding, backfill and special backfill, shoring, earthwork, connections to existing manholes and pipe, accessories, inspection and testing.

C. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit proposed methods, equipment, materials, and sequence of operations for force main construction.

C. Submit Shop Drawings and design calculations for joint restraint systems using reinforced concrete encasement of pressure pipe and fittings.

D. Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 TESTING

A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

2.0 PRODUCTS

2.01 DUCTILE IRON PIPE AND FITTINGS

A. Conform to requirements of Section 02634 – Ductile Iron Pipe and Fittings. All pipe used for sanitary sewer force mains shall be painted white.

2.02 PVC PIPE

A. Provide PVC pressure pipe conforming to the minimum working pressure rating specified in this Section. All pipe used for sanitary sewer force mains shall be white.

B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting the requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use EBAA Iron Series 2000PV, Uniflange Series 1350 restrainer, or equal joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.

C. Fittings: Provide ductile iron fittings as per this Section, 2.03 “Thrust Restraint”, except furnish all fittings with one of the following internal linings:

1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to the interior surface of the fitting, as manufactured by American Cast Iron Pipe "Polybond", or U.S. Pipe "Polyline".

2. Nominal 40 mils (35 mils minimum) polyurethane, Corro-pipe II by Madison Chemicals, Inc.

3. Nominal 40 mils (35 mils minimum) ceramic epoxy, Protecto 401 by Enduron Protective Coatings.

D. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with this Section, 3.04A "Hydrostatic Testing".

E. Manufacturers: Approved manufacturers of pressure rated, solid wall PVC pipe for sanitary sewer force mains are:

1. J & M Manufacturing Company, Inc.
2. CertainTeed Corporation
3. Diamond Plastics Corporation
4. Carlon Company
5. North American Pipe Corporation (NAPCO)

F. Provide lined ductile iron fittings conforming to Section 02634 – Ductile Iron Pipe and Fittings.

2.03 THRUST RESTRAINT

A. Unless otherwise shown on the Plans, provide concrete thrust blocking for force mains up to 12-inches in diameter, to prevent movement of buried lines under pressure at bends. Blocking shall be Portland cement concrete. Place concrete in accordance with details on the Plans. Place thrust blocks between undisturbed ground and the fittings. Anchor fittings to thrust blocks so that pipe and fitting joints are accessible for repairs. Concrete shall extend from 6 inches below the pipe or fitting to 12 inches above.

B. For all force mains larger than 12 inches in diameter, and where indicated on the Plans, provide restrained joints conforming to the requirements of the force main pipe material specifications. Restrained joints shall be installed for the length of pipe on both sides of each bend or fitting for the full length shown on the Plans.

C. Horizontal and vertical bends between zero and 10° deflection angle will not require thrust blocks or harnessed or restrained joints.

D. Horizontal and vertical bends between 10° and 90° deflection angle shall have thrust restraint as shown on the Plans.

E. Reinforced concrete encasement of force main pipe and fittings may be used in lieu of manufactured joint restraint systems. Alternate joint restraint systems using reinforced concrete encasement shall conform to the following design requirements.

1. Design calculations shall be performed and sealed by a Professional Engineer licensed in the State of Texas.

2. Design calculations shall be based upon soil parameters quantified in the geotechnical report for the site where the alternative thrust restraint system is to be installed. If data is not available for the site, use parameters recommended by the geotechnical engineer.

3. The design system pressure shall be the specified test pressure.

4. The following safety factors shall be used in sizing the restraint system:

   a. Apply a factor of safety equal to 1.5 for passive soil resistance.
   b. Apply a factor of safety equal to 2.0 for soil friction.

5. The encasement shall be contained entirely within the standard trench width and terminate on both ends at a pipe bell or coupling.

6. Concrete encasement reinforcement steel shall be designed for all loads including internal pressure and longitudinal forces. Concrete design shall be in accordance with ACI 318.

3.0 EXECUTION

3.01 PREPARATION

A. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.

3.02 PIPE INSTALLATION BY OPEN-CUT

A. Perform excavation, bedding, and backfill in accordance with Section 02318 – Excavation and Backfill for Utilities.

B. Install pipe in accordance with the pipe manufacturer's recommendations and as specified in this Section.

C. Install pipe only after excavation is completed, the bottom of the trench is fine graded, bedding material is installed, and the trench has been approved by the Engineer.

D. Install pipe to the line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in the trench so the interior surfaces of the pipe follow the grades and alignment indicated. Provide bell holes where necessary.

E. Install pipe with the spigot ends toward the direction of flow. Form a concentric joint with each section of adjoining pipe so as to prevent offsets.

F. Keep the interior of pipe clean as the installation progresses. Where cleaning after laying the pipe is difficult because of small pipe size, use a suitable swab or drag in the pipe and pull it forward past each joint immediately after the joint has been completed. Remove foreign material and debris from the pipe.

G. Provide lubricant, place and drive home newly-laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to "home" mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by the Engineer.

H. Keep excavations free of water during construction and until final inspection.

I. When work is not in progress, cover the exposed ends of pipes with an approved plug to prevent foreign material from entering the pipe.

J. Where sanitary sewer force main is to be installed under an existing waterline with a separation distance of less than 2 feet, install one full joint length of pipe centered on the waterline and maintain a minimum 6 inch separation distance.

3.03 PIPE INSTALLATION OTHER THAN OPEN-CUT

A. For installation of pipe by augering or jacking conform to requirements of specification sections for augering or jacking work.

3.04 FIELD QUALITY CONTROL

A. Hydrostatic Testing

1. After the pipe and appurtenance have been installed, test line and drain. Prevent damage to the Work or adjacent areas. Use clean water to perform tests.

2. The Engineer may direct tests of relatively short sections of completed lines to minimize traffic problems or potential public hazards.

3. Test pipe in the presence of the Engineer.

4. Test pipe at 150 psig or 1.5 times design pressure of the pipe, whichever is greater. Design pressure of the force main shall be the rated total dynamic head of the lift station pump.

5. Test pipe at the required pressure for a minimum of 2 hours according to requirements of UNI-B-3.

6. Maximum allowable leakage shall be as calculated by the following formula:

$$L = (S)\,(D)\,(P^{0.5}) / 133{,}200$$

Where:	L	=	Leakage in gallons per hour
	S	=	Length of pipe in feet
	D	=	Inside diameter of pipe in inches
	P	=	Pressure in pounds per square inch

7. Correct defects, cracks, or leakage by replacement of defective items or by repairs as approved by the Engineer.

8. Plug openings in the force main after testing and flushing. Use cast iron plugs or blind flanges to prevent debris from entering the tested pipeline.

B. Pigging Test

1. When requested by the Engineer and after completion of hydrostatic testing and prior to final acceptance, test force mains longer than 200 feet by pigging to ensure piping is free of obstructions.

2. Pigs: Provide proving pigs manufactured of an open-cell polyurethane foam body, without any coating or abrasives which would scratch or otherwise damage interior pipe wall surface or lining. Pigs shall be able to pass through reductions of up to 65 percent of the nominal cross-sectional area of the pipe. Pigs shall be able to pass through standard fittings such as 45° and 90° elbows, crosses, tees, wyes, gate valves, or plug valves, as applicable to the force main being tested.

3. Test Execution: Pigging test shall be conducted in the presence of the Engineer. Provide at least 48 hours notice of scheduled pigging of the force main prior to commencing the test.

4. All pigging tests shall be borne by the Contractor at no cost to the City.

END OF SECTION

Section 02534

PVC PIPE

1.0 GENERAL

1.01 SECTION INCLUDES

A. Polyvinyl chloride pressure pipe for water distribution in nominal diameters 4 inches through 16 inches.

B. Polyvinyl chloride sewer pipe for gravity sanitary sewers in nominal diameters 4 inches through 48 inches.

C. Polyvinyl chloride pressure pipe for gravity sanitary sewers and force mains in nominal diameters 4 inches through 36 inches.

D. References to Technical Specifications:

1. Section 01350 – Submittals
2. Section 02634 – Ductile Iron Pipe and Fittings
3. Section 02533 – Sanitary Sewage Force Mains
4. Section 02512 – Polyethylene Wrap
5. Section 02510 – Water Mains
6. Section 02530 – Gravity Sanitary Sewers
7. Section 02630 – Storm Sewers
8. Section 02318 – Excavation and Backfill for Utilities

E. Referenced Standards:

1. American Water Works Association (AWWA)

   a. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4" – 12" for Water Distribution.
   b. AWWA C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters, 14in. Through 36 in.
   c. AWWA C110 Ductile-Iron and Gray Iron Fittings for Water.

2. American Society for Testing and Materials (ASTM)

   a. ASTM D 1784, "Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds"
   b. ASTM F 477, "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe"

c. ASTM D 3139, "Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals"
d. ASTM D 3034, "Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings"
e. ASTM F 949, "Standard Specification for Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings"
f. ASTM D 794, "Standard Specification for Poly Vinyl Chloride (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter"
g. ASTM F 679, "Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings"
h. ASTM D 2241, "Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)"
i. ASTM D 3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals"
j. ASTM D 2444, "Standard Test Method for Determination for the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)"
k. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"
l. ASTM D 2321, "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications"

3. American National Standards Institute (ANSI)

a. ANSI A21.10 Cast Iron and Ductile Iron Fittings, 2 thru 48 in./Water.
b. ANSI A21.11 Rubber Gasket Joints Cast and Ductile Iron Press Pipe.

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for PVC pipe under this Section. Include cost in Bid Items for Water Mains, Gravity Sanitary Sewer, and Sanitary Sewage Force Mains.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit Shop Drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

1.04 QUALITY CONTROL

A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C900 or AWWA C905 for pressure pipe applications, or the appropriate ASTM standard specified for gravity sewer pipe.

B. Submit manufacturer's certification that PVC pressure pipe has been hydrostatically tested at the factory in accordance with AWWA C900 or AWWA C905 and this Section.

C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from any other source is not acceptable. Furnish copies of test reports to the Engineer for review. Cost of testing shall be borne by Contractor or Supplier.

2.0 PRODUCTS

2.01 MATERIAL

A. Use PVC compounds in the manufacture of pipe that contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.

B. Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for a rating of 4000 psi for water at 73.4 degrees F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.

C. For PVC pressure pipe used for water mains, provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.

D. Gaskets:

1. Gaskets shall meet the requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.

2. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following gasket materials for the noted contaminants.

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacturer

E. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.

2.02 WATER SERVICE PIPE

A. Pipe 4-inch through 12-inch: AWWAC900, Class 150, DR 18; nominal 20-foot lengths; cast iron equivalent outside diameters.

B. Pipe 16-inch: AWWA C905; Class 235; DR 18; nominal 20 foot lengths; cast iron equivalent outside diameter.

C. Joints: ASTM D 3139; push-on type joints in integral bell or separate sleeve couplings. Do not use socket type or solvent weld type joints.

D. Make curves and bends by deflecting the joints. Do not exceed maximum deflection recommended by the pipe manufacturer. Submit details of other methods of providing curves and bends for review by the Engineer.

E. Hydrostatic Test: AWWA C900, AWWA C905, ANSI A21.10 (AWWA C110); at point of manufacture; submit manufacturer's written certification.

2.03 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

A. Bends and Fittings: ANSI A21.10, ductile iron; ANSI A21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating.

B. Coatings and Linings: Conform to requirements of Section 02634 – Ductile Iron Pipe and Fittings.

2.04 GRAVITY SANITARY SEWER PIPE

A. PVC gravity sanitary sewer pipe shall be in accordance with the provisions in the following table:

WALL TYPE	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	SDR (MAX.) / STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed Can-Tex Carlon Diamond	Approved	D3034	SDR 26 / PS 115	6" to 15"
		Approved	F679	SDR 26 / PS 115	18" to 48"
		Approved	AWWA C900	DR 18 / N/A***	4" to 12"
		Approved	AWWA C905	DR 18 / N/A***	14" to 36"
Profile*	Contech A-2000**	Only when included in the Bid Schedule	F949	N/A / 50 psi	12" to 36"
	ETI Ultra-Rib		F794	N/A / 46 psi	12" to 48"
	Lamson Vylon		F794	N/A / 46 psi	21" to 48"

* Allowed to be used where there are no service taps.
** Allowed to be used to maximum depth of 10’ only.
*** For water-seer separation requirements unless specifically noted in Bid Schedule.

B. When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM F679, except provide wall thickness as required for SDR 26 and pipe strength of 115 psi.

C. For sewers up to 12-inch-diameter crossing over waterlines, or crossing under waterlines with less than 2 feet separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.

D. Joints: Spigot and integral wall section bell with solid cross section elastometric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477.

E. ASTM D 3139 and ASTM F 477 shall be provided. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. The manufacturer shall test a sample from each batch conforming to requirements ASTM D 2444.

F. Fittings: Provide PVC gravity sewer sanitary bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.

2.05 SANITARY SEWER FORCE MAIN PIPE

A. Provide PVC pressure pipe conforming to the requirements for water service pipe, and conforming to the minimum working pressure rating specified in Section 02533 – Sanitary Sewage Force Mains.

B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting the requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use EBAA Iron Series 2000PV, Uniflange Series 1350 restrainer, or equal joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.

C. Fittings: Provide ductile iron fittings as per this Section, 2.03 "Bends and Fittings for PVC Pressure Pipe", except furnish all fittings with one of the following internal linings:

1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to the interior surface of the fitting, as manufactured by American Cast Iron Pipe "Polybond", or U.S. Pipe "Polyline".

2. Nominal 40 mils (35 mils minimum) polyurethane, Corro-pipe II by Madison Chemicals, Inc.

3. Nominal 40 mils (35 mils minimum) ceramic epoxy, Protecto 401 by Enduron Protective Coatings.

D. Exterior Protection: Provide polyethylene wrapping of ductile iron fittings as required by Section 02512 – Polyethylene Wrap.

E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with this Section, 2.02E.

F. Manufacturers: Approved manufacturers of pressure rated, solid wall PVC pipe for sanitary sewer force mains are:

1. J & M Manufacturing Company, Inc.
2. CertainTeed Corporation
3. Diamond Plastics Corporation
4. Carlon Company
5. North American Pipe Corporation (NAPCO)

3.0 EXECUTION

3.01 PROTECTION

A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with the manufacturer's recommendations.

3.02 INSTALLATION

A. Conform to requirements of Section 02510 – Water Mains, Section 02530 – Gravity Sanitary Sewers, Section 02731 – Sanitary Sewage Force Mains, and Section 02630 – Storm Sewers.

B. Install PVC pipe in accordance with Section 02318 – Excavation and Backfill for Utilities, ASTM D 2321, and manufacturer's recommendations.

C. Water service pipe 12 inches in diameter and smaller: Installed to clear utility lines and have minimum 4 feet of cover below lowest property line grade of street, unless otherwise required by Plans.

D. For water service, exclude use of PVC within 200 feet (along the public right-of-way) of underground storage tanks or in undeveloped commercial acreage. Underground storage tanks are primarily located on service stations but can exist at other commercial establishments.

E. Avoid imposing strains that will overstress or buckle the pipe when lowering pipe into trench.

F. Hand shovel pipe bedding under the pipe haunches and along the sides of the pipe barrel and compact to eliminate voids and ensure side support.

END OF SECTION

Section 02534

PVC PIPE

1.0 GENERAL

1.01 SECTION INCLUDES

A. Polyvinyl chloride pressure pipe for water distribution in nominal diameters 4 inches through 16 inches.

B. Polyvinyl chloride sewer pipe for gravity sanitary sewers in nominal diameters 4 inches through 48 inches.

C. Polyvinyl chloride pressure pipe for gravity sanitary sewers and force mains in nominal diameters 4 inches through 36 inches.

D. References to Technical Specifications:

1. Section 01350 – Submittals
2. Section 02634 – Ductile Iron Pipe and Fittings
3. Section 02533 – Sanitary Sewage Force Mains
4. Section 02512 – Polyethylene Wrap
5. Section 02510 – Water Mains
6. Section 02530 – Gravity Sanitary Sewers
7. Section 02731 – Sanitary Sewage Force Mains
8. Section 02630 – Storm Sewers
9. Section 02318 – Excavation and Backfill for Utilities

E. Referenced Standards:

1. American Water Works Association (AWWA)

    a. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4" – 36" for Water Distribution.
    b. AWWA C110 Ductile-Iron and Gray Iron Fittings for Water.

2. American Society for Testing and Materials (ASTM)

    a. ASTM D 1784, "Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds"
    b. ASTM F 477, "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe"

c. ASTM D 3139, "Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals"
d. ASTM D 3034, "Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings"
e. ASTM F 949, "Standard Specification for Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings"
f. ASTM D 794, "Standard Specification for Poly Vinyl Chloride (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter"
g. ASTM F 679, "Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings"
h. ASTM D 2241, "Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)"
i. ASTM D 3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals"
j. ASTM D 2444, "Standard Test Method for Determination for the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)"
k. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"
l. ASTM D 2321, "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications"

3. American National Standards Institute (ANSI)

a. ANSI A21.10 Cast Iron and Ductile Iron Fittings, 2 thru 48 in./Water.
b. ANSI A21.11 Rubber Gasket Joints Cast and Ductile Iron Press Pipe.

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for PVC pipe under this Section. Include cost in Bid Items for Water Mains, Gravity Sanitary Sewer, and Sanitary Sewage Force Mains.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit Shop Drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

1.04 QUALITY CONTROL

A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C900 pressure pipe applications, or the appropriate ASTM standard specified for gravity sewer pipe.

B. Submit manufacturer's certification that PVC pressure pipe has been hydrostatically tested at the factory in accordance with AWWA C900 and this Section.

C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from any other source is not acceptable. Furnish copies of test reports to the Engineer for review. Cost of testing shall be borne by Contractor or Supplier.

2.0 PRODUCTS

2.01 MATERIAL

A. Use PVC compounds in the manufacture of pipe that contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.

B. Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for a rating of 4000 psi for water at 73.4 degrees F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.

C. For PVC pressure pipe used for water mains, provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.

D. Gaskets:

1. Gaskets shall meet the requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.

2. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following gasket materials for the noted contaminants.

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacturer

E. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.

2.02 WATER SERVICE PIPE

A. Pipe 4-inch through 24-inch: AWWAC900, Class 235, DR18; nominal 20-foot lengths; ductile iron equivalent outside (DIPS) diameters.

B. Pipe 24-inch and above: AWWA C900, Class 165, DR25; nominal 20-foot lengths; ductile iron equivalent (DIPS) outside diameters.

C. Joints: ASTM D 3139; push-on type joints in integral bell or separate sleeve couplings. Do not use socket type or solvent weld type joints.

D. Make curves and bends by deflecting the joints. Do not exceed maximum deflection recommended by the pipe manufacturer. Submit details of other methods of providing curves and bends for review by the Engineer.

E. Hydrostatic Test: AWWA C900, ANSI A21.10 (AWWA C110); at point of manufacture; submit manufacturer's written certification.

2.03 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

A. Bends and Fittings: ANSI A21.10, ductile iron; ANSI A21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating.

B. Coatings and Linings: Conform to requirements of Section 02634 – Ductile Iron Pipe and Fittings.

2.04 GRAVITY SANITARY SEWER PIPE

A. PVC gravity sanitary sewer pipe shall be in accordance with the provisions in the following table:

WALL TYPE	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	SDR (MAX.) / STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed Can-Tex Carlon Diamond	Approved	D3034	SDR 26 / PS 115	6" to 15"
		Approved	F679	SDR 26 / PS 115	18" to 48"
		Approved	AWWA C900	DR 18 / N/A***	4" to 36"
Profile*	Contech A-2000**	Only when included in the Bid Schedule	F949	N/A / 50 psi	12" to 36"
	ETI Ultra-Rib		F794	N/A / 46 psi	12" to 48"
	Lamson Vylon		F794	N/A / 46 psi	21" to 48"

* Allowed to be used where there are no service taps.
** Allowed to be used to maximum depth of 10’ only.
*** For water-seer separation requirements unless specifically noted in Bid Schedule.

B. When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM F679, except provide wall thickness as required for SDR 26 and pipe strength of 115 psi.

C. For sewers up to 12-inch-diameter crossing over waterlines, or crossing under waterlines with less than 2 feet separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.

D. Joints: Spigot and integral wall section bell with solid cross section elastometric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477.

E. ASTM D 3139 and ASTM F 477 shall be provided. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. The manufacturer shall test a sample from each batch conforming to requirements ASTM D 2444.

F. Fittings: Provide PVC gravity sewer sanitary bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.

2.05 SANITARY SEWER FORCE MAIN PIPE

A. Provide PVC pressure pipe conforming to the requirements for water service pipe, and conforming to the minimum working pressure rating specified in Section 02533 – Sanitary Sewage Force Mains.

B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting the requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use EBAA Iron Series 2000PV, Uniflange Series 1350 restrainer, or equal joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.

C. Fittings: Provide ductile iron fittings as per this Section, 2.03 "Bends and Fittings for PVC Pressure Pipe", except furnish all fittings with one of the following internal linings:

1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to the interior surface of the fitting, as manufactured by American Cast Iron Pipe "Polybond", or U.S. Pipe "Polyline".

2. Nominal 40 mils (35 mils minimum) polyurethane, Corro-pipe II by Madison Chemicals, Inc.

3. Nominal 40 mils (35 mils minimum) ceramic epoxy, Protecto 401 by Enduron Protective Coatings.

D. Exterior Protection: Provide polyethylene wrapping of ductile iron fittings as required by Section 02512 – Polyethylene Wrap.

E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with this Section, 2.02E.

F. Pipe color shall be green.

G. Manufacturers: Approved manufacturers of pressure rated, solid wall PVC pipe for sanitary sewer force mains are:

1. J & M Manufacturing Company, Inc.
2. CertainTeed Corporation
3. Diamond Plastics Corporation
4. Carlon Company
5. North American Pipe Corporation (NAPCO)

3.0 EXECUTION

3.01 PROTECTION

A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with the manufacturer's recommendations.

3.02 INSTALLATION

A. Conform to requirements of Section 02510 – Water Mains, Section 02530 – Gravity Sanitary Sewers, Section 02731 – Sanitary Sewage Force Mains, and Section 02630 – Storm Sewers.

B. Install PVC pipe in accordance with Section 02318 – Excavation and Backfill for Utilities, ASTM D 2321, and manufacturer's recommendations.

C. Water service pipe 12 inches in diameter and smaller: Installed to clear utility lines and have minimum 4 feet of cover below lowest property line grade of street, unless otherwise required by Plans.

D. For water service, exclude use of PVC within 200 feet (along the public right-of-way) of underground storage tanks or in undeveloped commercial acreage. Underground storage tanks are primarily located on service stations but can exist at other commercial establishments.

E. Avoid imposing strains that will overstress or buckle the pipe when lowering pipe into trench.

F. Hand shovel pipe bedding under the pipe haunches and along the sides of the pipe barrel and compact to eliminate voids and ensure side support.

END OF SECTION

Section 02540

TAPPING SLEEVES & VALVES

1.0 GENERAL

1.01 SECTION INCLUDES

A Tapping sleeves and valves for connections to existing water system.

B References to Technical Specifications:
1. Section 01200 – Measurement & Payment Procedures
2. Section 01350 – Submittals
3. Section 02541 – Water & Wastewater Line Valves
4. Section 02520 – Valve Boxes, Meter Boxes, & Meter Vaults
5. Section 02512 – Polyethylene Wrap
6. Section 02318 – Excavation & Backfill for Utilities

C Referenced Standards:
1. American Water Works Association (AWWA)
   a. AWWA C500 Gate Valves, 3 Through 48 in. NPS, for Water and Sewage Systems.
   b. AWWA C110 Ductile-Iron and Gray Iron Fittings for Water
   c. AWWA C207 Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In.

1.02 MEASUREMENT AND PAYMENT

A Measurement for installation of tapping sleeves and valves is on a per each basis. Payment includes all labor and materials required for installation as indicated on Plans.

B Refer to Section 01200 – Measurement & Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

1.04 QUALITY CONTROL

A Provide manufacturer's affidavit that all valves purchased for tapping of existing waterlines conform to Section 02541 – Water & Wastewater Line Valves and to applicable requirements of AWWA C500 and that they have been satisfactorily tested in accordance with AWWA C500.

2.0 PRODUCTS

2.01 MATERIALS

A Tapping Sleeves:

1. Tapping Sleeve Bodies: Stainless steel; in two sections to be bolted together with high-strength, corrosion-resistant, low-alloy, steel bolts; mechanical joint ends.
   a. 12 inch and smaller: stainless steel; JCM 432, Romac, or approved equal.
   b. 16 inch and larger: epoxy coated ductile iron; JCM, or approved equal.
2. Branch Outlet of Tapping Sleeve: Flanged; machined recess; AWWA C207, Class D, ANSI 150 lb drilling. Gasket: Affixed around recess of tap opening to preclude rolling or binding during installation.
3. Where fire service from 6-inch main is approved, use cast iron split sleeve.

B Tapping Valves: Meet all requirements of Section 02541 – Water & Wastewater Line Valves with following exceptions:

1. Inlet Flanges:
   a. AWWA C110; Class 125.
   b. AWWA C110; Class 150 and higher: Minimum eight hole flange.
2. Outlet: Standard mechanical or push-on joint; to fit any standard tapping machine.
3. Valve Seat Opening: Accommodate full-size shell cutter for nominal size tap without any contact with valve body; double disc.
4. Open Left operation only.

C Valve Boxes: Furnish and install according to Section 02520 – Valve Boxes, Meter Boxes, & Meter Vaults.

3.0 EXECUTION

3.01 GENERAL

A Install tapping sleeves and valves at locations and of sizes as shown on Drawings.

B Thoroughly clean tapping sleeve, tapping valve and pipe prior to installation and in accordance with manufacturer's instructions.

C Hydrostatically test installed tapping sleeve to 150 psig for a minimum of 15 minutes. Inspect sleeve for leaks, and remedy leaks prior to tapping operation.

D When tapping concrete pressure pipe, size on size, use shell cutter one standard size smaller than waterline being tapped.

E Do not use Large End Bell (LEB) increasers with a next size tap unless existing pipe is asbestos-cement.

3.02 INSTALLATION

A Tighten bolts in proper sequence so that undue stress is not placed on pipe.

B Align tapping valve properly and attach it to tapping sleeve.

C Make tap with sharp, shell cutter:
1. For 12-inch and smaller tap, use minimum cutter diameter one-half inch less than nominal tap size.
2. For 16-inch and larger tap, use manufacturer's recommended cutter diameter.

D Withdraw coupon and flush all cuttings from newly-made tap.

E Wrap completed tapping sleeve and valve in accordance with Section 02512 – Polyethylene Wrap.

F Place concrete thrust block behind tapping sleeve (NOT over tapping sleeve and valve).

G Block under valve using concrete blocks.

H Request inspection of installation prior to backfilling.

I Backfill in accordance with Section 02318 – Excavation & Backfill for Utilities.

END OF SECTION

Section 02541

WATER AND WASTEWATER LINE VALVES

1.0 GENERAL

1.01 SECTION INCLUDES

A Gate valves, Plug Valves, Butterfly Valves, Air Release and Pressure Reducing Valves.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 - Submittal Procedures
3. Section 02520 – Valve Boxes, Meter Boxes, and Meter Vaults
4. Section 02542 – Concrete Manholes
5. Section 02318 – Excavation and Backfill for Utilities
6. Section 02510 – Water Mains

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM A 307, "Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength"
   b. ASTM B 763, "Standard Specification for Copper Alloy Sand Casting for Valve Applications"
   c. ASTM B 62, "Standard Specification for Composition Bronze or Ounce Metal Castings"
   d. ASTM D 429, "Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates"
   e. ASTM A 126, "Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings"
   f. ASTM A 48, "Standard Specification for Gray Iron Castings"
   g. ASTM A 240, "Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications"
   h. ASTM A 276, "Standard Specification for Stainless Steel Bars and Shapes"
   i. ASTM B 584, "Standard Specification for Copper Alloy Sand Castings for General Applications"
   j. ASTM A 313, "Standard Specification for Stainless Steel Spring Wire"
2. American Water Works Association (AWWA)
   a. AWWA C500 Gate Valves, 3 Through 48 in. NPS, for Water and Sewage Systems.
   b. AWWA C509 or AWWA C515 Resilient-seated Gate Valves, 3 through 12 NPS, for Water and Sewage Systems
   c. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
   d. AWWA C504 Rubber-Sealed Butterfly Valves

3. American National Standards Institute (ANSI)

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for valves under this Section. Include cost in Bid Items for water mains.

B Refer to Section 01200 – Measurement and Payment Procedures.

C Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit manufacturer's product data for proposed valves for approval.

1.04 QUALITY CONTROL

A Submit manufacturer's affidavit that gate valves are manufactured in the United States and conform to stated requirements of AWWA C500, AWWA C509 and AWWA C515 and this Section, and that they have been satisfactorily tested in the United States in accordance with AWWA C500, AWWA C509 and AWWA C515.

2.0 PRODUCTS

2.01 GATE VALVES

A Gate Valves: AWWA C500, AWWA C509 or C515 and additional requirements of this Section. Direct bury valves and those in subsurface vaults, aboveground and plant valves open counterclockwise.

B If type of valve is not indicated on Plans, use gate valves as line valves for sizes less than 16-inches. If type of valve is indicated, no substitute is allowed.

C Gate Valves 1-1/2 Inches in Diameter and Smaller: 125 psig; bronze; rising-stem; single-wedge; disc type; screwed ends; such as Crane No. 428, or approved equal.

D Coatings for Gate Valves 2 Inches and Larger: AWWA C550; Indurall 3300 or approved equal, non-toxic, imparts no taste to water, functions as physical, chemical, and electrical barrier between base metal and surroundings, minimum 8-mil-thick, fusion-bonded epoxy. Prior to assembly of valve, apply protective coating to interior and exterior surfaces of body.

E Gate Valves 2 Inches in Diameter: Iron body, double gate, non-rising stem, 150-pound test, 2 inch square nut operating clockwise to open.

F Gate Valves 4 Inches to 12 Inches in Diameter: Non-directional, resilient seated (AWWA C509 or AWWA C515) or parallel seat double disc (AWWA C500), 200 psig, bronze mounting, push-on bell ends with rubber joint rings, and nut-operated unless otherwise specified. Provide resilient seated valves manufactured by American Darling AFC-500, US Pipe Metroseal 200, or approved equal. Provide double disc valves manufactured by American Darling 52, Clow F-6102, or approved equal. Comply with following requirements:

1. Design: Fully encapsulated rubber wedge or rubber seat ring mechanically attached with minimum 304 stainless-steel fasteners or screws; threaded connection isolated from water by compressed rubber around opening.
2. Body: Cast or ductile iron, flange bonnet and stuffing box together with ASTM A 307 Grade B bolts. Manufacturer's initials, pressure rating, and year manufactured shall be cast in body.
3. Bronze: Valve components in waterway to contain no more than 15 percent zinc and not more than 2 percent aluminum.
4. Stems: ASTM B 763 bronze, alloy number 995 minimum yield strength of 40,000 psi; minimum elongation in 2 inches of 12 percent, non-rising.
5. O-rings: AWWA C509, sections 2.2.6 and 4.8.2.
6. Stem Seals: Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar.
7. Stem Nut: Independent or integrally cast of ASTM B 62 bronze.
8. Resilient Wedge: Molded, synthetic rubber, vulcanized and bonded to cast or ductile iron wedge or attached with 304 stainless steel screws tested to meet or exceed ASTM D 429, Method B; seat against epoxy-coated surface in valve body.
9. Bolts: AWWA C509 Section 4.4; stainless steel; cadmium plated, or zinc coated.

G Gate Valves 16 Inches to 24 Inches in Diameter: AWWA C500 by Mueller; push-on bell ends with rubber rings and nut-operated unless otherwise specified, double disc, 150 psi, and comply with the following:

1. Body: Cast or ductile iron; flange together bonnet and stuffing box with ASTM A 307 Grade B bolts. Manufacturer's initials, pressure rating, and year manufactured shall be cast in body. Equip with rollers, tracks, and scrapers.
2. Stems: Machined from ASTM B 62 bronze rod with integral forged thrust collar machined to size; non-rising.
3. Stem Seals: Consist of one O-ring above and one O-ring below thrust collar with anti-friction washer located above thrust collar for operating torque.
4. Stem Nut: Independent or integrally cast of ASTM B 62 bronze.
5. Discs: Cast iron with bronze disc rings securely peened into machined dovetailed grooves.
6. Wedging Device: Solid bronze or cast-iron, bronze-mounted wedges. Thin plates or shapes integrally cast into cast-iron surfaces are acceptable. Other moving surfaces integral to wedging action shall be bronze monel or nickel alloy-to-iron.

7. Bronze Mounting: Built as integral unit mounted over, or supported on, cast iron base and of sufficient dimensions to be structurally sound and adequate for imposed forces.
8. Gear Cases: Cast iron; furnished on 18-inch and larger valves and of extended type with steel side plates, lubricated, gear case enclosed with oil seal or O-rings at shaft openings.
9. Stuffing Boxes: Located on top of bonnet and outside gear case.

H Gate Valves 20 Inches and Larger: Furnish and equip with bypass valves.
1. Sizes: Provide 3-inch bypass valves for 16-inch through 20 inch gate valves. Provide 4-inch bypass valves for 24-inch gate valves.

I Valves 4 Inches through 12 Inches for Installation in Vertical Pipe Lines:
1. Double disc, square bottom.

J Valves 14 Inches and Larger for Installation in Horizontal Pipe Lines:
1. Equipped with bronze shoes and slides.

K Gate Valves Installed at Greater than 4 foot Depth:
1. Provide non-rising, extension stem having coupling sufficient to attach securely to operating nut of valve. Upper end of extension stem shall terminate in square wrench nut no deeper than 4 feet from finished grade.

L Gate Valves in Factory Mutual (Fire Service) Type Meter Installations:
1. Conform to provisions of this specification; outside screw and yoke valves; carry label of Underwriters' Laboratories, Inc.; flanged, Class 125; clockwise to close.

M Provide flanged joints when valve is connected to steel or PCCP.

2.02 BUTTERFLY VALVES AND ACTUATORS

A Butterfly Valves and Actuators: Conform to AWWA C504, except as modified or supplemented herein. Provide valves manufactured by Keystone International, American-Darling, or approved equal.

B If type of valve is not indicated on Plans, butterfly valves shall be used for line valve sizes 16 inch and larger. If type of valve is specified, no substitute will be allowed.

C Butterfly valves shall be short-body, flanged design and installed at locations as shown on Plans.

D Direct-bury valves, valves in subsurface vaults. Above-ground and plant valves shall open counterclockwise.

E Provide flanged joints when valve is connected to steel or PCCP.

F Butterfly Valves and Actuators (Additional Requirements for Large-Diameter Water Mains): Valves larger than 72 inches in diameter shall have all components designed

so that the allowable stresses at rated pressure shall not exceed one-third of the yield strength or one-fifth of the ultimate strength of the material used. Provide valves manufactured by Keystone International, American-Darling, or equal.

2.03 BUTTERFLY VALVE CONSTRUCTION

A Valves: AWWA C504, Class 150B. Body: Cast iron, ASTM A 126, Class B. Flanges: ANSI B 16.1, Class 125 lb.

B Discs for Butterfly Valves: Either cast iron or ductile iron.

C Seats: Buna-N or neoprene, and may be applied to disc or body. Seats shall be mechanically secured and may not rely solely on adhesive properties of epoxy or similar bonding agent to attach seat to body. Seats on disc shall be mechanically retained by stainless steel (18 - 8) retaining ring held in place by stainless steel (18 - 8) cap screws that pass through rubber seat for added retention. When seat is on disc, seat shall be retained in position by shoulders located on both disc and stainless-steel retaining ring. Mating surfaces for seats: Type 304 or 316, stainless steel and secured to disc by mechanical means. Sprayed-on or plated mating surfaces will not be allowed.

D Coat interior wetted ferrous surfaces of valve, including disc, with epoxy suitable for potable-water conditions. Epoxy, surface preparation, and epoxy application: In accordance with AWWA C550 and coating manufacturer's recommendations. Provide two coats of two-component, high-build epoxy with minimum dry thickness of 10 mils. Epoxy coating: Indurall 3300 or approved equal. Coatings shall be holiday tested and measured for thickness.

E Valve shaft and keys, dowel pins, or taper pins used for attaching valve shaft to valve disc: Type-304 or 316 stainless steel. Shaft Bearings: Stainless steel, bronze, nylon, or Teflon (supported by fiberglass mat or backing material with proven record of preventing Teflon flow under load) in accordance with AWWA C504.

F Packing: Field-adjustable, split-V type, and replaceable without removing operator assembly.

G Retaining Hardware for Seats: Type 304 or 316 stainless steel. Nuts and screws used with clamps and discs for rubber seats shall be held securely with locktight, or other approved method, to prevent loosening by vibration or cavitational effects.

H Valve disc shall seat in position at 90 degrees to the pipe axis and shall rotate 90 degrees between full-open and tight-closed position. Install valves with valve shafts horizontal and convex side of disc facing anticipated direction of flow, except where shown otherwise on Plans.

2.04 BUTTERFLY VALVE ACTUATOR CONSTRUCTION

A Provide actuators for valves with size based on line velocity of 16 feet per second, and, unless otherwise shown on Plans, equip with geared manual actuators. Provide

fully enclosed and traveling-nut type, rack-and-pinion type, or worm-gear type for valves 24 inches and smaller.

B Provide actuator designed for installation with valve shaft horizontal unless otherwise indicated on Plans.

C Provide valve shaft extended from valve to actuator. Space between actuator housing and valve body shall be completely enclosed so that no moving parts are exposed to soil or elements.

D Provide oil-tight and watertight actuator housings for valves, specifically designed for buried service or submerged service when located in valve vaults, and factory packed with suitable grease.

E Install a valve position indicator on each actuator housing located above ground or in valve vaults. Valves shall be equipped with 2-inch actuator nut only.

F Indicate direction of opening of valve on exposed visible part of assembly.

G Design worm-gear or traveling-nut actuators so that a torque of 150 foot-pounds, or less, will operate valve at most adverse condition for which valve is designed. Vertical axis of actuating nut shall not move as valve is opened or closed.

2.05 VALVE BOXES

A Provide standard adjustable valve boxes only conforming to requirements of Section 02520 – Valve Boxes, Meter Boxes, and Meter Vaults.

2.06 VALVE SERVICE MANHOLES

A For large-diameter water mains, provide manholes to dimensions shown on Plans conforming to requirements of Section 02542 – Concrete Manholes.

2.07 AIR RELEASE AND VACUUM RELIEF VALVES

A Air Release Valves: Apco No. 200, GA Industries Fig. 2-AR, or equal. Materials: body and cover, ASTM A 48, Class 30, cast iron; float and leverage mechanism, ASTM A 240 or A276 stainless steel; orifice and seat, stainless steel against Buna-N or Viton mechanically retained with hex head nut and bolt; other valve internals, stainless steel or bronze. Provide inlet and outlet connections, and orifice as shown on Plans.

B Air Release and Vacuum Valves: Provide single-body, standard combination or duplex-body custom combination valves as indicated on Plans.

1. For 2 inch and 3 inch, single-body valves, provide inlet and outlet sizes as shown on Plans and orifice sized for 100 psi working pressure. Valve materials: body, cover and baffle, ASTM A 48, Class 35, or ASTM A 126, Grade B cast iron; plug or poppet, ASTM A 276 stainless steel; float, ASTM A 240 stainless steel; seat, Buna-N; other valve internals, stainless steel. Valve exterior: Painted with shop-applied primer suitable for contact with potable

water. Provide Apco Model 145C or 147C, Val-Matic Series 200, or equal valves.

2. For 3 inch and larger duplex body valves as shown on Plans, provide Apco Series 1700 with No. 200 air release valve, GA Industries Fig. No. AR/GH-21K/280, or equal. Air and vacuum valve materials: body and cover, ASTM A 48, Class 35, cast iron; float, ASTM A 240 stainless steel; seat, Type-304, stainless steel and Buna-N; other valve internals, stainless steel or bronze. Air release valve: Constructed as specified in paragraph above on Air Release Valves.

C Vacuum Relief Valves: Provide air inlet vacuum relief valves with flanged inlet and outlet connections as shown on Plans. Provide air release valves in combination with inlet and outlet, and orifice as shown on Plans. Valve shall open under pressure differential not to exceed 0.25 psi. Provide Apco Series 1500 with a No. 200A air release valve, GA Industries Fig. No. HCARV, or approved equal. Materials for vacuum relief valves: valve body, ASTM A 48, Class 35, cast iron; seat and plug, ASTM B 584 bronze, copper alloy 836; spring, ASTM A 313, Type-304, stainless steel; bushing, ASTM B 584 bronze, copper alloy 932; retaining screws, ASTM A 276, Type-304, stainless steel.

D Air Release Valve Vault as detailed in Plans.

2.08 PRESSURE REDUCING VALVES

A Provide Cla-Val Model 90-01, or approved equal, PRV with strainer in location and arrangement as shown on Plans. Valve body: ASTM A 48, cast iron or ASTM A 126, Class B, cast iron with ANSI B16.1, Class 125, flanges. Valve cover: ASTM A 48 cast iron. Valve internals: Type-303, stainless steel or B-62 bronze. Rubber parts: Buna-N. No leather parts shall be allowed. Resilient seat shall have rectangular cross section.

B Control Tubing: Contain shutoff cocks with "Y" strainer.

C PRV: Equip with valve position indicator. Initially set in field by authorized manufacturer's representative with 60 psi downstream pressure.

D Provide basket strainer upstream of PRV as shown on Plans. Strainer body: quick-opening type, fabricated-steel construction with ANSI B16.1, Class 150, flanges. Basket: Type-304, stainless steel. Provide Hayward Model 90, or equal, for PRV 4-inch through 24-inch. Provide Hayward Model 510, or equal, for PRV 14 inches or greater when space limitations dictate the use of smaller strainer housing.

E Pilot Systems for PRV: Adjustable and pressure sustaining.

F Valve Box: Valve Box conforming to requirements of Section 02520 – Valve Boxes, Meter boxes, and Meter Vaults.

3.0 EXECUTION

3.01 INSTALLATION

A Earthwork. Conform to applicable provisions of Section 02318 – Excavation and Backfill for Utilities.

B Operation. Do not use valves for throttling without prior approval of manufacturer.

3.02 SETTING VALVES AND VALVE BOXES

A Remove foreign matter from within valves prior to installation. Inspect valves in open and closed positions to verify that parts are in satisfactory working condition.

B Install valves and valve boxes where shown on Plans. Set valves plumb and as detailed. Center valve boxes on valves. Carefully tamp earth around each valve box for minimum radius of 4 feet, or to undisturbed trench face if less than 4 feet. Install valves completely closed when placed in water line.

C For pipe section of each valve box, use only cast iron, ductile iron, or DR18 PVC pipe cut to proper length. Size to allow future operation of valve. Assemble and brace box in vertical position as indicated on Plans.

3.03 DISINFECTION AND TESTING

A Perform disinfection and testing of valves and appurtenances as required by Section 02510 – Water Mains.

B Repair or replace valves which exceed the allowable specified leakage rate.

3.04 PAINTING OF VALVES

A Paint valves in vaults, stations, and above ground using ACRO Paint No. 2215, or approved equal.

END OF SECTION

Section 02542

CONCRETE MANHOLES AND ACCESSORIES

1.0 GENERAL

1.01 SECTION INCLUDES

A. Pre-Cast Concrete Manholes for sanitary.

B. Pre-Cast and Cast-in-Place Manholes for storm sewer.

C. Iron castings for manhole frames and covers, inlet frames and grates, catch basin frames and grates, meter vault frames and covers, adjustment rings and extensions.

D. Ring grates.

E. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01500 – Temporary Facilities and Controls
4. Section 03300 – Cast-in-Place Concrete
5. Section 02255 – Bedding, Backfill, and Embankment Materials
6. Section 02318 – Excavation and Backfill for Utilities
7. Section 02530 – Gravity Sanitary Sewers
8. Section 01140 – Contractor's Use of Premises

F. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM C 478, "Standard Specification for Precast Reinforced Concrete Manhole Sections"
b. ASTM C 443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
c. ASTM C 270, "Standard Specification for Mortar for Unit Masonry"
d. ASTM C 923, "Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals"
e. ASTM C 1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)"
f. ASTM A 48, "Standard Specification for Gray Iron Castings"
g. ASTM A 615, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"
h. ASTM D 698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort"

2. American Association of State Highway and Transportation Officials (AASHTO)

3. American Water Works Association (AWWA)

4. American Welding Society (AWS)
   a. AWS D12.1, "Reinforcing Steel Welding Code"

5. Texas Commission on Environmental Quality (TCEQ)
   a. Chapter 217.55 "Minimum Clear Opening"

G. Definitions:

1. Shallow Depth Manholes- manholes having a depth of 4 feet or less measured from the top of cover to sewer invert.

2. Normal Depth Manholes- manholes having a depth of greater than 4 feet and up to 8 feet measured from top of cover to sewer invert.

3. Extra Depth Manholes- manholes having a depth of greater than 8 feet measured from the top of cover to sewer invert.

4. Corrosion Resistant Manholes- concrete manholes incorporating additional material, such as liners or coatings, which make them more resistant to corrosion than typical concrete manholes.

5. Standard Manholes Drops- drops of up to 3 vertical feet measured from the invert of the T-fitting to the sewer invert.

6. Extra Depth Manhole Drops- drops in excess of 3 vertical feet measured from the invert of the T-fitting to the sewer invert.

1.02 MEASUREMENT AND PAYMENT

A. Measurement for Normal Depth Manholes and/or Normal Depth Corrosion Resistant Manholes shall be per each.

B. Measurement for Shallow Depth Manholes and/or Shallow Depth Corrosion Resistant Manholes shall be per each.

C. Measurement for Extra Depth Manholes and/or Extra Depth Corrosion Resistant Manholes is on a vertical foot basis for each foot of depth greater than 8 feet.

D. Payment for Manholes under this Section shall be for complete installation including riser, frames, grates, adjustment rings, stainless steel inflow preventers, cut-in work, covers, penetrations, other appurtenances, and be in accordance with Section 01200 – Measurement and Payment Procedures.

E. Measurement for Standard Manhole Drops shall be per each.

F. Measurement for Extra Depth Manhole Drops is on a vertical foot basis for each foot of Drop greater than 3 feet.

G. Payment for Drops under this Section shall be for assembly components, encasement, other appurtenances, and be in accordance with Section 01200 – Measurement and Payment Procedures.

H. Payment for Air Release Manhole with Valves and Fittings installed is on a unit price basis for each manhole with air release valves, fittings and appurtenances installed and in accordance with Section 01200 Measurement and Payment Procedures.

1.03 PERFORMANCE REQUIREMENTS

A. Perform work needed to make manholes structurally sound, improve flow, prevent entrance of inflow or groundwater, prevent entrance of soil or debris, and provide protection against hydrogen sulfide gas attack.

B. Manufacturer's Product Support.

1. Through the Contractor, manufacturers of wall sealing or lining systems shall submit to Engineer for review and approval a detailed description of the proposed coating installation process. Describe surface preparation, independent laboratory test results, mix design procedures and method of controlling uniform thickness.

2. A representative employed by the manufacturer and having technical training in epoxy or cementitious liner shall be named and available for consultation by telephone during business hours and on site upon 48 hours notice.

3. Manufacturer's representative on concrete lining systems shall provide technical assistance to applicators to ensure proper usage of dispensing equipment and accurate proportions of admixtures.

1.04 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit proposed design mix and test data for each type and strength of concrete.

C. Submit manufacturer's data and details of following items for approval:

1. Frames, grates, rings, and covers.

2. Materials to be used in fabricating drops.

3. Materials to be used for pipe connections at manhole walls.

4. Materials to be used for stubs and stub plugs.

5. Plugs to be used for sanitary sewer hydrostatic testing.

6. Shop Drawings of manhole sections and base units and construction details, including reinforcement, jointing methods, materials and dimensions.

7. Certification from manufacturer that precast manhole design is in full accordance with ASTM C 478 and design criteria as established in this Section, 2.03E, "Design Loading Criteria".

8. Product data, materials and procedures for corrosion resistant liner and coatings, if required. For coating and resistant liner systems requiring 10-yr manufacturer warranty, submit specific coating system including product, thickness, and application for Engineer's approval.

9. Manufacturer's data for pre-mix (bag) concrete, if used for channel inverts and benches.

D. Installer Qualifications: Installers of liners and wall repair systems shall submit qualifications to Engineer at least 14 days prior to start of any material application. Submittal shall consist of:

1. Manufacturer's approved equipment list, by name and model number for application of product and contractor's equipment list showing approved equipment available for use in product application.

2. List of contractor's personnel who have satisfactorily completed manufacturer's training in product application within previous two years. Include date of certification for each person.

E. Provide Shop Drawings for fabrication and erection of casting assemblies. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include Setting Drawings for location and installation of castings and anchorage devices.

2.0 PRODUCTS

2.01 MATERIALS

A. Concrete shall conform to requirements in Section 03300 - Cast-In Place Concrete.

B. Minimum concrete compressive strength of 4000 psi.

C. Reinforcing Steel shall conform to requirement in Section 03300 - Cast-In Place Concrete.

D. Mortar shall conform to requirements of ASTM C 270, Type S using Portland cement.

2.02 PRECAST CONCRETE MANHOLES

A. Use manhole sections and base sections conforming to ASTM C 478. Use base riser section with integral floors, unless shown otherwise. Provide adjustment rings which are standard components of the manufacturer of the manhole sections meeting material requirements of ASTM C 478. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

B. Construct barrels for precast manholes from 48-inch diameter standard reinforced concrete manhole sections unless otherwise indicated on Plans. Use various lengths of manhole sections in combination to provide the correct height with the fewest joints. Wall sections shall be designed for depth as shown and loading conditions as described in this Section, 2.03E, "Design Load Criteria", but shall not be less than 5 inches thick. Base section shall have a minimum thickness of 12 inches under the invert.

C. Provide cone tops to receive 30-inch cast iron frames and covers, unless indicated otherwise. Use tops designed to support an AASHTO H-20 loading.

D. Where the Plans indicate that manholes larger than 48-inch diameter are required, precast base sections of the required diameter shall be provided with flat slab top precast sections used to transition to 48-inch diameter manhole access riser sections. Transition can be concentric or eccentric. The transition shall be located to provide a minimum of 7-foot head clearance from the top of bench to underside of transition.

E. Design Loading Criteria: The manhole walls, transition slabs, cone tops, and manhole base slab shall be designed by the manufacturer to the requirements of ASTM C 478 for the depth as shown on Plans and the following design criteria:

1. AASHTO H-20 loading applied to the manhole cover and transmitted down to the transition and base slabs.

2. Unit soil weight of 120 pcf located above all portions of the manhole, including base slab projections.

3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf, with soil pressure acting on empty manhole.

4. Internal liquid pressure based on a unit weight of 63 pcf, with manhole filled with liquid from invert to cover, with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the transition and base slabs.

6. Design additional reinforcing steel to transfer stresses at openings.

7. The minimum clear distance between any two wall penetrations shall be 12 inches or half the diameter of the smaller penetration, whichever is greater.

F. Form joints between sections with O-ring gaskets conforming to ASTM C 443.

G. Do not incorporate manhole steps in manhole sections.

H. Do not use brick masonry in construction of sanitary sewer manholes.

2.03 MISCELLANEOUS METALS

A. Provide cast-iron frames, grates, rings, covers, and stainless steel inflow preventers conforming to requirements of this Section and the City of Baytown Standard Construction Details.

2.04 DROPS

A. Drops shall conform to the same pipe material requirements used in the main pipe, unless otherwise indicated on the Plans.

2.05 PIPE CONNECTIONS

A. Use resilient connectors conforming to requirements of ASTM C 923. Metallic mechanical devices as defined in ASTM C 923 shall be made of the following materials:

1. External clamps:
   a. Type 304 stainless steel.

2. Internal, expandable clamps on standard manholes:
   a. Type 304 stainless steel, 11 gage minimum.

3. Internal, expandable clamps on corrosion-resistant manholes:
   a. Type 316 stainless steel, 11 gage minimum.
   b. Type 304 stainless steel, 11 gage minimum, coated with minimum 16 mm fusion-bonded epoxy conforming to AWWA C-213.

4. All precast openings shall be fully circular, 360º openings.

B. Where rigid joints between pipe and a cast-in-place manhole base are specified or shown on the Plans, use polyethylene-isoprene water-stop meeting the physical property requirements of ASTM C 923, Press-Seal WS Series, or equal.

C. Storm sewer pipe connections:

1. Connections acceptable for sanitary sewers.

2. Line pipe grouted in place with mortar. Rehabilitate.

2.06 WALL CLEANING MATERIAL

A. Cleaners: Detergent or muriatic acid capable of removing dirt, grease, oil and other matter which would prevent a good bond of sealing material to wall. Refer to sealing material manufacturer's recommendations.

2.07 SEALANT MATERIALS

A. Sealing materials between precast concrete adjustment ring and manhole cover frame shall be Adeka Ultraseal P201, or approved equal.

2.08 WALL REPAIR MATERIALS

A. Hydraulic Cements: Use a blend of cement powders or hydraulic cement to stop active leaks in the manhole structure.

B. Quickset Mortar: Use a quickset mortar to repair wide cracks, holes or disintegrated mortar.

2.09 CORROSION RESISTANT MANHOLE MATERIALS

A. Provide one of the following as indicated on the Plans:

1. Precast cylindrical Portland cement concrete sanitary sewer manhole sections, base sections, and cone sections with one of the following factory applied internal coatings or approved equal:

a. NeoPoxy™ NPR-5300 Series "PureEpoxy" spray on epoxy liner and other required fillers/sealants per manufacturer's recommendations:

b. NeoPoxy NPR-3501 high tensile elongation epoxy elastomeric gout and sealant.

c. NeoPoxy NPR-5305 trowelable epoxy filler, grout and sealant,

d. Chemical and cementitious rapid set hydraulic grouts such as Strong-Plug, Strong-Seal QSR, Quadex Hyperform and Quadex Hydro-Plug, or other equivalents pre-approved by the engineer.

e. NeoPoxy P-88 ultraviolet light resistant topcoat.

f. EMACO liner (contact City of Baytown Public Works Department for specific type).

g. Raven liner (contact City of Baytown Public Works Department for specific type).

h. SewperCoat 100% Calcium aluminate by Kerneos™ Aluminate Technologies.

2. Type I Coating: The manufacturer of these applied products shall provide a minimum 10-year material and labor warranty. A 10-year manufacturer warranty shall be applicable for the following sanitary sewer manholes:

a. Manholes that receive force main discharge.

b. Manholes within the lift/pump station site including last manhole before wet well.

c. Manholes with 5 feet diameter and larger or manholes that receive discharge from 15" or larger diameter gravity sewer.

d. Manholes as determined by City Engineer.

3. Type II Coating: All other sanitary sewer manholes shall be coated with minimum 125 mil thick coating of products specified in Section 2.09.1.a-d, or approved equal.

2.10 BACKFILL MATERIALS

A. Backfill materials shall conform to the requirements of Section 02255 – Bedding, Backfill, and Embankment Materials.

2.11 NON-SHRINK GROUT

A. For non-shrink grout, use prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. It shall meet the requirements of ASTM C 1107 and shall have a minimum 28-day compressive strength of 7000 psi.

2.12 CASTINGS

A. Castings for frames, grates, rings and covers shall conform to City of Baytown Standard Construction Details and shall be ASTM A 48, Class 30. Provide locking covers if indicated on Plans.

B. Castings shall be capable of withstanding the application of an AASHTO H-20 loading without permanent deformation.

C. Fabricate castings to conform to the shapes, dimensions, and with wording or logos shown on the Plans.

D. Castings shall be clean, free from blowholes and other surface imperfections. Cast holes in covers shall be clean and symmetrical, free of plugs.

2.13 BEARING SURFACES

A. Machine bearing surfaces between covers or grates and their respective frames so that even bearing is provided for any position in which the casting may be seated in the frame.

2.14 SPECIAL FRAMES AND COVERS

A. Where indicated on the Plans, provide watertight manhole frames and covers with a minimum of four bolts and a gasket designed to seal cover to frame. Supply watertight manhole covers and frames, Model R-1916 manufactured by Neenah Foundry Company, Model V-2420 by East Jordan Iron Works, or approval equal.

B. Where personnel entry is anticipated, minimum clear openings of 30-inches is required.

2.15 FABRICATED RING GRATES

A. Ring grates shall be fabricated from reinforcing steel conforming to ASTM A 615.

B. Welds connecting the bars shall conform to AWS D12.1.

2.16 INFLOW PREVENTERS

A. Provide stainless steel inflow preventers with air release vents on all sanitary sewer manholes.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify lines and grades are correct.

B. Determine if the subgrade, when scarified and re-compacted, can be compacted to 95 percent of maximum Standard Proctor Density according to ASTM D 698 prior to placement of foundation material and base section. If it cannot be compacted to that density, the subgrade shall be moisture conditioned until that density can be reached or shall be treated as an unstable subgrade.

C. Do not build sanitary or storm sewer manholes in ditches, swales, or drainage paths unless approved by the Engineer.

3.02 PLACEMENT OF PRECAST MANHOLES

A. Install precast manholes to conform to locations and dimensions shown on Plans.

B. Place manholes at points of change of alignment, grade, size, pipe intersections, and end of sewer.

3.03 MANHOLE BASE SECTIONS AND FOUNDATIONS

A. Place precast base on 12-inch-thick (minimum) foundation of cement stabilized sand or a concrete foundation slab. Compact cement-sand in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities.

B. Unstable Subgrade Treatment: When unstable subgrade is encountered, the subgrade will be examined by the Engineer to determine if the subgrade has heaved upwards after being excavated. If heaving has not occurred, the subgrade shall be over-excavated to allow for a 24-inch thick layer of crushed stone wrapped in filter fabric as the foundation material under the manhole base. If there is evidence of heaving, a pile-supported concrete foundation, as detailed on the Plans, shall be provided under the manhole base, when indicated by the Engineer.

3.04 PRECAST MANHOLE SECTIONS

A. Install sections, joints, and gaskets in accordance with manufacturer's printed recommendations.

B. Install precast or steel adjustment rings above tops of cones or flat-top sections as required to adjust the finished elevation and to support manhole frame.

C. Seal any lifting holes with non-shrink grout.

D. Where PVC liners are required, seal joints between sections in accordance with manufacturers recommendations.

3.05 PIPE CONNECTIONS AT MANHOLE

A. Install approved resilient connectors at each pipe entering and exiting sanitary sewer manholes in accordance with manufacturer's instructions.

B. Ensure that no concrete, cement stabilized sand, fill, or other rigid material is allowed to enter the space between the pipe and the edge of the wall opening at and around the resilient connector on either the interior or exterior of the manhole. If necessary, fill the space with a compressible material to guarantee the full flexibility provided by the resilient connector. All pipe openings shall be fully circular, 360° openings.

C. Where a new manhole is to be constructed on an existing sewer, install precast manhole base with factory installed Fernco type connections and pipe stubouts at least two (2) feet outside manhole wall. Manhole shall be cut-in to existing pipe. No “horseshoe” or “dog house” type connections will be permitted.

D. Do not construct joints on sanitary sewer pipe within wall sections of manholes. Use approved connection material.

E. Construct pipe stubs with resilient connectors for future connections at locations and with material indicated on Plans. Install approved stub plugs at interior of manhole.

F. Test connection for watertight seal before backfilling.

3.06 INVERTS FOR SANITARY SEWERS

A. Construct invert channels to provide a smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:

1. Slope of invert bench: 1 inch per foot minimum; 1-1/2 inch per foot maximum.

2. Depth of bench to invert:
   Pipes smaller than 15-inches: one-half largest pipe diameter
   Pipes 15 to 24-inches: three-fourths the largest pipe diameter
   Pipes larger than 24-inches: equal to the largest pipe diameter

3. Invert slope through manhole: 0.10-foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on Plans.

B. Form invert channels with class A concrete if not integral with manhole base. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.07 DROPS FOR SANITARY SEWERS

A. Construct Drops with same materials used in main pipe unless otherwise indicated on Plans or approved by the Engineer. Install a Drop when a sewer line enters a manhole higher than 30-inches above the invert of the manhole. All drops must be interior drops.

B. Terminate encasement of blind drops a minimum of 5 inches below top of bell and not less than 12 inches above top of next lower bell. Install approved plug at bell.

3.08 MANHOLE FRAME AND ADJUSTMENT RINGS

A. Combine precast concrete adjustment rings so that the elevation of the installed casting cover is 3/8 inch below the pavement surface. Seal between adjustment ring and the manhole top with non-shrink grout; do not use mortar between adjustment rings. Apply a latex-based bonding agent to concrete surfaces to be joined with non-shrink grout. Set the cast iron frame on the adjustment ring in a bed of approved sealant. The sealant bed shall consist of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 3/4-inch wide.

B. For manholes in unpaved areas, top of frame shall be set a minimum of 6 inches above existing ground line unless otherwise indicated on Plans. In unpaved areas, encase the manhole frame in mortar or non-shrink grout placed flush with the face of the manhole ring and the top edge of the frame. Provide a rounded corner around the perimeter.

3.09 BACKFILL

A. Place and compact backfill materials in the area of excavation surrounding manholes in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities. Use embedment zone backfill material, as specified for the adjacent utilities, from manhole foundation up to an elevation 12 inches over each pipe connected to the manhole. Provide trench zone backfill, as specified for the adjacent utilities, above the embedment zone backfill.

B. Where rigid joints are used for connecting existing sewers to the manhole, backfill under the existing sewer up to the spring-line of the pipe with Class B concrete or flowable fill.

3.10 MANHOLE WALL CLEANING

A. The floor and interior walls of the manhole shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, oils, grease, sludge, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate.

1. High pressure water blasting with a minimum of 3,500 psi shall be used to clean free all foreign material within the manhole

2. When grease and oil are present within the manhole, an approved detergent or muriatic acid shall be used integrally with the high pressure cleaning water.

3. All materials resulting from the cleaning of the manhole shall be removed prior to application of the coating.

4. All loose grout, ledges, steps and protruding ledges shall be removed to provide an even surface prior to application of coating.

B. Prevent any foreign material from entering the adjoining pipes. Remove droppings of foreign and wall sealant materials before they harden on the bottom of the manhole.

C. No separate pay shall be made for this item. Include cost for sealing in the unit price for manholes.

D. Manufacturer's representative shall be available at all times on site to answer questions and approve manhole preparation work prior to lining.

3.11 MANHOLE WALL SEALING

A. Seal active leaks in the manhole structure by using non-shrink grout.

B. Remove loose or defective wall material. Wipe or brush surface clean prior to the application of hydraulic cement

C. Drill weep holes at bottom of manhole walls to relieve hydrostatic pressure to stop leaks. Plug pressure relief holes after leaks are stopped using hydraulic cement materials. Lead wool may also be used to plug large leaks.

D. Repair wide cracks, or holes with quickset mortars. Follow manufacturer's application procedures.

E. Shape manhole inverts before wall sealing work. Apply concrete to cleaned manhole benches as specified in Section 03300.

F. After all active leaks have been stopped, clean and prepare walls for application of selected liner material.

G. Properly apply the sealing compound to provide the minimum required uniform coating to the wall surface.

H. Prevent any foreign material from entering the adjoining pipes. Remove droppings of foreign and wall sealant materials before they harden on the bottom of the manhole.

I. Strictly follow product manufacturer's published technical specifications and recommendations for surface preparation, application and proportioning.

3.12 FIELD QUALITY CONTROL

A. Conduct leakage testing of manholes in accordance with requirements of Section 02530 – Gravity Sanitary Sewers. Vacuum test shall be completed prior to coating of the manhole.

3.13 INSPECTION

A. After manhole wall sealing has been completed, visually inspect the manhole in the presence of Engineer. Check for cleanliness and for elimination of active leaks.

B. At completion of manhole construction, assist Engineer in verifying installation of minimum coating thickness of concrete liner. Test several points on the manhole wall. Repair verification points prior to final acceptance for payment.

C. During application of corrosion resistant liner, a wet film thickness gauge, meeting ASTM D4414, shall be used. Measurements shall be taken, documented and attested by the Contractor for submission to the Owner.

D. At completion of manhole construction, assist Engineer in inspection of installation.

3.14 TESTING

A. After the coating product(s) have set in accordance with manufacturer's instructions, all surfaces shall be inspected for holidays with high-voltage holiday detection equipment. Reference NACE RPO 188-99 for performing holiday detection. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations. Documentation on areas tested, results and repairs made shall be provided to Owner by Contractor.

B. Visual inspection shall be made by the Project Engineer and/or Inspector. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Contractor.

3.15 CLEAN-UP AND RESTORATION

A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

3.16 PROTECTION OF THE WORK

A. Protect Manholes from damage until subsequent work has been accepted.

B. Repair or replace damaged elements of Manholes at no additional cost to the Owner.

C. In unpaved areas, provide positive drainage away from manhole frame to natural grade.

END OF SECTION

THERMOPLASTIC PAVEMENT MARKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thermoplastic pavement markings.

1.02 UNIT PRICES

A. Measurement for linear pavement markings is on a linear foot basis for each width, measured in place.

B. Measurement for words and symbols is on a lump sum basis for each word or symbol.

C. Refer to Section 01025 – Measurement and Payment for unit price procedures.

1.03 SUBMITTALS

A. Submittals shall conform to requirements of Section 01300 – Submittals.

B. Each container shall be clearly marked to indicate the color, weight, Type of material, manufacturer's name and the lot/batch number.

PART 2 PRODUCTS

A. Pavement markings are thermoplastic type marking materials that require heating to elevated temperatures for application.

B. Materials shall conform to TxDOT Specification Item 666.

PART 3 EXECUTION

3.01 GENERAL

A. Prepare pavement surfaces and install markings in accordance with manufacturer's recommendations and TxDOT specifications.

B. Accurately locate and install approved markings to conform to classes, colors, lengths, widths, and configurations indicated on Drawings.

3.02 PREPARATION

A. Clean and repair surfaces to receive markups. Blast clean surfaces indicated on Drawings or where directed by the Engineer in accordance with requirements of Section 02581. Do not clean portland cement concrete pavements by grinding.

3.04 SURFACE INSTALLATION

A. Test pavement surface for moisture content prior to application of markings. Place an approximate 2 square foot sheet of clear plastic or tar paper on road surface and hold in place for 20 minutes. Immediately inspect the sheet for buildup of condensed moisture. If sufficient moisture has condensed to cause water to drip from sheet, do not apply markings. Repeat test as necessary until adequate moisture has evaporated from pavement to allow placement.

B. Observe manufacturer's recommended pavement and ambient air temperature requirements for application. If manufacturer has no temperature recommendations, do not install markings if pavement temperature is below 60 degrees F or above 120 degrees F.

C. Prime pavement surface and apply markings as recommended by manufacturer.

3.05 FIELD QUALITY CONTROL

A. Pavement markings shall present a neat, uniform appearance.

B. Repair or replace improperly installed markers at Contractors expense.

3.06 CLEANING

A. Keep project site free of unnecessary traffic hazards at all times.

B. Clean area upon completion of work and remove rubbish from work site.

3.07 WARRANTY

A. Contractor shall warrant material and labor for a period of twelve months from date of installation of markings. Immediately upon notification, replace portions of pavement marking lines or legends that have lifted, shifted or spread, lost daytime color, or nighttime retro-reflectivity.

END OF SECTION

Section 02603

FRAMES, GRATES, RINGS, AND COVERS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Iron castings for manhole frames and covers, inlet frames and grates, catch basin frames and grates, meter vault frames and covers, adjustment rings and extensions.

B. Ring grates.

C. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 - Submittals

D. Referenced Standards:

1. American Society for Testing and Materials (ASTM)
   a. ASTM A 48, "Standard Specification for Gray Iron Castings"
   b. ASTM A 615, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"
   c. ASTM C 270, "Standard Specification for Mortar for Unit Masonry"

2. American Association of State Highway and Transportation Officials (AASHTO)
   a. AASHTO M 306, "Drainage, Sewage, Utility, and Related Castings"

3. American Welding Society (AWS)
   a. AWS D12.1, "Reinforcing Steel Welding Code"

4. Texas Commission on Environmental Quality (TCEQ)
   a. Chapter 217.55 "Minimum Clear Opening"

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for frames, grates, rings, covers, and seals under this Section. Include cost in Bid Items for which this Work is a component.

B. If frames, grates, rings, covers, and seals are included as a Bid Items, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Provide copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions. Manufacturer shall be East Jordan Iron Works, Inc. or as approved by public works.

C. Provide Shop Drawings for fabrication and erection of casting assemblies. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include Setting Drawings for location and installation of castings and anchorage devices.

2.0 PRODUCTS

2.01 CASTINGS

A. Castings for frames, grates, rings and covers shall conform to ASTM A 48, Class 35B and AASHTO M 306. Provide locking covers if indicated on Plans.

B. Castings shall be capable of withstanding the application of an AASHTO H-20 loading without permanent deformation.

C. Fabricate castings to conform to the shapes, dimensions, and with wording or logos shown on the Plans.

D. Castings shall be 75% post-consumer recycled material, clean, free from blowholes and other surface imperfections. Cast holes in covers shall be clean and symmetrical, free of plugs.

2.02 BEARING SURFACES

A. Machine bearing surfaces between covers or grates and their respective frames so that even bearing is provided for any position in which the casting may be seated in the frame.

2.03 SPECIAL FRAMES AND COVERS

A. Where indicated on the Plans, provide stainless steel inflow preventers and watertight manhole frames and covers with a minimum of four bolts and a gasket designed to seal cover to frame. Supply watertight manhole Frames and Covers, Model R-1916 manufactured by Neenah Foundry Company, Model V-2420 by East Jordan Iron Works, or as approved by public works.

B. Where personnel entry is anticipated, minimum clear opening of 30-inches is required.

2.04 FABRICATED RING GRATES

A. Ring grates shall be fabricated from reinforcing steel conforming to ASTM A 615.

B. Welds connecting the bars shall conform to AWS D12.1.

2.05 MORTAR

A. Conform to requirements of ASTM C 270, Type S using Portland cement.

3.0 EXECUTION

3.01 INSTALLATION

A. All installations that have an elevation difference between the final elevation of the manhole cover and the surrounding finished grade greater than 18 inches will be required to be hinged, lift assist gasketed ring and cover.

B. Install castings according to approved Shop Drawings, instructions given in related Sections, and applicable directions from the manufacturer's printed materials.

C. Set castings accurately at required locations to proper alignment and elevation. Keep castings plumb, level, true and free of rack. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in formwork until permanently set.

D. Ring grates shall be fabricated in accordance with Plans and shall be set in mortar in the mouth of the pipe bell.

END OF SECTION

Section 02624

STRUCTURAL PLATE CULVERT STRUCTURES

1.0 GENERAL

1.01 SECTION INCLUDES

A Structural plate culverts and special structural plate shapes.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 03300 – Cast-in-Place Concrete
4. Section 02318 – Excavation and Backfill for Utilities

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM A 153, "Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   b. ASTM B 695, "Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
   c. ASTM B 221, "Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
2. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT

A Measurement for structural plate pipes, pipe arches, arches, underpasses or box culverts is on a linear foot basis, measured along flow lines between ends of structures. Separate measurement will be made for each different required size, gage, or minimum thickness of the required material.

B For multiple structures, the measured length will be the sum of the lengths of barrels as prescribed above.

C Payment for structural plate culvert structures includes aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, and all labor and materials required for installation as indicated on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 ACCEPTANCE AT SITE

A Furnish an itemized statement of the number and size of plates in each shipment. From this list, a visual inspection will be made by the Engineer, including an examination of the plates for deficiency in size, radius of curvature specified, and any evidence of poor workmanship. The inspection may include taking samples for chemical analysis and determination of weight of splutter coating. The plates making up the shipment shall fully meet the requirement of these specifications. Any plates failing to do so shall be rejected.

B The Engineer may elect to have the material inspected and sampled in the rolling mill or in the fabrication shop. A chemical analysis of any plate may be required from the mill. The inspection, either in the mill or in the shop, will be under the direction of the Engineer. The Engineer will have free access to the mill or shop for inspection. Any material which has been previously rejected at the mill or shop and included in a later lot will be rejected unless the material has been satisfactorily repaired.

C Structural plate with a damaged splutter coating, or which shows defective workmanship shall be rejected. Minor damaged areas of splutter coating, as judged by the Engineer, may be repaired by painting with a zinc dust-zinc oxide paint conforming to Federal Specification TT-P-641g. The requirement applies not only to individual plates but to the entire shipment.

D The following defects are considered to be poor workmanship. The presence of any one of them in an individual structural plate will be cause for rejection:

1. Uneven laps.
2. Elliptical shaping (unless specified).
3. Variation from a straight center line.
4. Ragged edges and damaged coatings.
5. Loose, uneven lined or spaced bolts.
6. Illegible brand.
7. Bruised, scaled or broken splutter coating.
8. Dents or bends in the metal.

2.0 PRODUCTS

2.01 METAL PIPE AND ARCH MATERIALS

A Plates and fasteners used for construction of structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes shall conform to AASHTO M167 for galvanized corrugated steel structures and to AASHTO M219 for aluminum alloy structures.

B Steel fasteners shall be mechanically galvanized or hot-dip galvanized and shall conform to ASTM A 153, Class C or D, or ASTM B 695, Class 40. The weight of galvanized coating shall be determined according to Test Method Tex-728-I.

C Steel plates shall consist of structural units of corrugated galvanized steel. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet. Plates will have approximately a 2 inch lip beyond each end and crest, which results in the actual length of a given structure being approximately 4 inches longer than the nominal length, except when skewed or beveled.

D Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of one foot. When required, aluminum alloy inverts, toe walls, footings and closure plates shall conform to the material requirements for the aluminum structural plate. Extruded aluminum transverse stiffeners shall conform to ASTM B 221, Alloy 6061-T6.

E The material for metal headwalls shall comply with requirements shown on the Plans.

2.02 STRUCTURE AND MATERIAL DESIGNATION

A The types of structures will be indicated on the Plans by one of the following descriptions:

1. Structural Plate Pipe (Galvanized. Steel)
2. Structural Plate Pipe (Alum.)
3. Structural Plate Pipe Arch (Galvanized. Steel)
4. Structural Plate Pipe Arch (Alum.)
5. Structural Plate Arch (Galvanized. Steel)
6. Structural Plate Arch (Alum.)
7. Structural Plate Underpass (Galvanized. Steel)
8. Structural Plate Underpass (Alum.)
9. Structural Plate Box Culvert (Galvanized. Steel)
10. Structural Plate Box Culvert (Alum.)

B When designated as one of the above types without the material being designated, the Contractor may furnish the structure in either galvanized steel or aluminum.

2.03 PLATE JOINTS

A Form plates to provide bolted lap joints. Punch bolt holes so that plates having like dimensions, curvature, and the same number of bolts per foot of seam are interchangeable.

B Curve each plate to proper radius so that cross-sectional dimensions of finished structure will be as indicated on Plans.

C Stagger joints so that not more than three plates are jointed at any one point. Unless otherwise specified, place bolt holes along those edges of plates that will form longitudinal seams in the finished structure as follows:

1. Stagger in rows 2 inches apart, with one row in the valley and one in the crest of corrugations with not less than 4 bolts per foot for galvanized steel structures.

2. Stagger in rows 1 ¾ inches apart with 2 bolts in each valley and on each crest and not less than 16 bolts per 3 feet for aluminum alloy structures.

D Provide for a bolt spacing of not more than 12 inches for bolt holes along edges of plates that will form circumferential seams in finished structure.

E Keep minimum distance from center of hole to edge of plate to not less than 1 ¾ times diameter of bolt.

F For the diameter of bolt holes in longitudinal seams do not exceed diameter of the bolt. Diameter of bolt holes in longitudinal seams shall not exceed diameter of bolt by more than 1/8 inch.

G Cut plates for forming skewed or sloped ends to give the angle of skew or slope specified.

H Repair burned edges to eliminate oxide and burrs. Maintain legible identification numerals on each plate to designate its proper position in the finished structure.

2.04 CONCRETE

A Concrete shall conform to Section 03300 – Cast-in-Place Concrete. Unless otherwise shown on the Plans, use Class A concrete for footings and headwalls. Use Class B concrete for slope protection and for invert paving, when required. Place reinforcement as shown on the Plans.

2.05 REINFORCING STEEL

A Reinforcing steel shall conform to requirements of Section 03300 – Cast-in-Place Concrete.

3.0 EXECUTION

3.01 PROTECTIVE COATINGS, LININGS AND PAVINGS

A When required, protect structural plate structures with bituminous coating, bituminous lining or have invert paved with bituminous material. Remove moisture, dirt, oil, unbonded or incompatible paint, grease, alkalies, or other foreign matter from the surface to be coated before applying the coating material.

B When specified or called in the Plans apply bituminous coatings to inside and outside of structures to a minimum thickness of 0.05 inch as provided in AASHTO M190, Type A.

C Apply a protective coating to coupling bands for coated structures. Use coatings in accordance with AASHTO M190. Coupling bands may be single-dipped with the coating thickness requirement waived.

D Apply bituminous linings, if required, over bituminous coatings, to inside bottom portion of structure as provided in AASHTO M190, Type C.

E When linings and pavings are not required, an asphalt mastic coating may be substituted for bituminous coating on corrugated steel or aluminum structures on outside surface of the structure. The inside surface need not be coated.

F When specified or called in the Plans, use an asphalt mastic coating conforming to requirements of AASHTO M243, except that asbestos fibers will not be used. Perform this process at the fabrication plant. Apply asphalt mastic material uniformly to the outside surface with a minimum thickness of 0.05 inch. Pinholes, blisters, cracks or lack of bond are cause for rejection.

G When protective coatings are applied to structures, be sure that the thickness of metal is clearly identified on the inner surface of each section with paint or other approved means. Repair damaged protective coatings, linings and invert paving. Use bituminous material conforming to provisions of AASHTO M190 or other approved materials to repair damaged asphalt mastic coatings.

H Coat that portion of nuts and bolts projecting outside the pipe after installation. The portion of nuts and bolts projecting inside the structure need not be coated.

I When asphalt mastic is used for protective coating, the surface at joints of the structure need not be coated prior to assembly. Thoroughly seal joints after assembly with asphalt mastic on outside of the structure.

3.02 CONSTRUCTION METHODS

A Excavate in accordance with Section 02318 – Excavation and Backfill for Utilities. Make trenches for pipes, pipe arches, underpasses or box culverts of sufficient width to provide free working space for erection and thorough tamping of backfill and bedding material under and around the structure. If the quality of the native soil is less than that of the proposed backfill material, extended the excavation to each side of the barrel, a minimum horizontal distance of half the span or two-thirds of the total rise, whichever is greater.

B Foundations, Structural Plate Structures with Metal Inverts: Have these structures bedded in a foundation of sandy earth material carefully and accurately shaped to fit the lower part of the pipe for at least ten percent of its overall height. However, the length of bedding arch need not exceed the width of the bottom plate. Obtain uniform seating of corrugations on pipe bed by placing the sandy material at least 3 inches thick. For culverts, place bedding to full width of the invert.

1. Excavation in Rock: Where rock, in either ledge or boulder formation, is encountered, remove it below grade and replace with a compacted earth cushion having a thickness of not less than 1/2 inch per foot height of fill over top of the pipe, with the minimum allowable thickness of 12 inches and a maximum of 24 inches under the pipe.
2. Where the soil encountered at the established grade is a quicksand, muck or similar unstable material, remove and replace it in accordance with Section 02318– Excavation and Backfill for Utilities. When required, use special bedding as shown on Plans.

C Foundations, Structural Plate Structures with Reinforced Concrete Footings: Form footings for these structures and finish them to true lines and grades as established by Engineer.

1. Set anchors or slots for box culverts to true line and grade when placing concrete for each substructure unit. Conform to Section 03300– Cast-in-Place Concrete for placing substructure units.
2. Place footings entirely in rock, shale or similarly hard material, or on firm soil or compacted soil cushion. When part of the founding area is rock, undercut it and replace it with a minimum 12 inch thick compacted soil cushion. When a thin layer of soil is partially covering rock within the bearing area and when practical to do so, soil may be removed and footings placed directly on rock in accordance with details shown on Plans.

D Erection: Install structural plate structures in accordance with Plans and manufacturer's recommendations.

1. Coat any steel in joints which is not protected by galvanizing with suitable bituminous coating.
2. Handle pipes and plates carefully to avoid damage to any protective coating. Repair damaged coatings.
3. For anchoring plates to headwalls or other concrete end treatment, use anchor bolts with ¾ inch diameter by 6 inch minimum length on not more than 19-inch centers.
4. Do not place plates for arch structures until the concrete cement substructure has cured for a minimum of 3 days.
5. When all plates are in position, tighten nuts and bolts progressively and uniformly, beginning at one end of the structure. Tighten nuts a second time to a torque of not less than 150 ft-lbs nor more than 300 ft-lbs for steel bolts and not less than 100 ft-lbs nor more than 150 ft-lbs for aluminum bolts. If an impact wrench is used, check with a long-handled, structural or socket wrench or a torque wrench to ensure that they are properly tightened. Replace service bolts used in drawing the plates together with standard high strength bolts.

E Shape Control: Furnish acceptable shape control devices for monitoring horizontal and vertical shape of structures. Maintain the shape within two percent of design measurements span or rise, whichever is greater or 5 inches, whichever is less, during erection and backfilling.

F Backfilling: Perform backfilling and embankment construction around the pipe in accordance with Section 02318– Excavation and Backfill for Utilities, except as modified below.

1. Within vertical planes 2 feet beyond the horizontal limits of the structure and until a minimum of 2 feet of cover has been compacted over the structure, only hand operated, mechanical tamping equipment shall be permitted.
2. Unless otherwise shown, no heavy earth moving equipment shall be permitted to haul over the structure until a minimum of 2 feet of permanent or temporary compacted fill has been placed. Remove and replace plates or structures damaged by equipment or backfilling operation.

3. During backfilling, to avoid unequal pressures and produce uniformly compacted backfill material of uniform density throughout the length of the structure and ensure proper backfill under the structure.
4. Prior to adding each new layer of loose backfill material, until a minimum 2 feet of cover is obtained, an inspection will be made of the inside periphery of the structure to determine any local or unequal deformation caused by improper construction methods.
5. Backfill the structure so that when backfill is complete the inside dimensions are within tolerances set forth in shape control. In the case of arches other than pipe arches when backfilling is completed before headwalls are placed, place the first material midway between ends of the arch, forming as narrow a ramp as possible until the top of the arch is reached. Construct the ramp evenly from both sides. Thoroughly the backfilling material as it is placed. After two ramps have been constructed to the top of the arch, deposit the remainder of backfill from the top of the arch both ways from the center, to the ends and as evenly as possible on both sides of the arch. If headwalls are built before the arch is backfilled, place fill material first adjacent to one headwall until the top of the arch has been reached, after which fill shall be dumped from the top of the arch toward the other headwall, with care being taken to deposit material evenly on both sides of the arch.
6. For multiple structures, perform same backfill process for all structures more or less simultaneously. Backfilling between barrels will usually require that the material be placed with a crane and bucket or other suitable equipment. Do not drop backfill material from a height or concentrated in such an amount prior to distribution over the top arc that damage to the flexible structure will result. Compact this backfill with hand operated tampers or other equipment acceptable to Engineer.

END OF SECTION

Section 02628

JACKING PIPE OR BOX

1.0 GENERAL

1.01 SECTION INCLUDES

A Description-Furnish and install pipe or box by jacking.

B Direct Jacking

Direct jacking of concrete box is a method of installing a Precast Reinforced Concrete Box (RCB) under roadways, railways, runway or highways in lieu of the open cut method. The box jacking procedure uses a PIPE OR BOX that is suitable to be jacked through the soil; sizes range from an end area of approximately 32 square feet to 144 square feet (8' x 4' to 12' x 12'). Maximum jacking loads are controlled by pumping bentonite or suitable lubricants around the outside of the box during the jacking operation. Typically, jacks are oversized so they can be operated at a lower pressure and maintain a reserve jacking capacity. It is common, although not mandatory, to use a 24-hour operation when pushing box, reducing the possibility that the box will freeze or "set" in the ground.

C References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 02255 – Bedding, Backfill, and Embankment Materials
5. Section 02318 – Excavation and Backfill for Utilities
6. Section 02415 – Augering Pipe or Casing for Sewers
7. Section 01140 – Contractor's Use of Premises

D Referenced Standards:

1. American Society for Testing and Materials (ASTM)
2. ASTM C 76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
3. ASTM C 443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
4. ASTM C 506, "Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe"
5. ASTM C 877, "Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections"
6. ASTM C 507, "Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe"
7. ASTM C 655, "Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe"
8. ASTM D 3350, "Standard Specification for Polyethylene Plastic Pipe and Fittings Materials"

9. ASTM C 1433, "Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers"
10. ASTM B 633, "Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel"
11. ASTM A 760, "Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains"
12. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT

A Measurement for storm sewers is on a linear foot basis taken along the center line of the pipe from center line to center line of manholes or from end to end of culverts, measured and complete in place. Separate measurement will be made for each type and size of pipe installed.

B Payment for storm sewer includes pipe, earthwork, connections to existing manholes and pipe, accessories, equipment and execution required or incidental to storm sewer work.

C Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Tunnel specialist to be performing the work on the job must submit a letter of qualification to the Owner outlining:

1. A successful history of direct jacking box;
2. Have successfully completed direct jack installations of equal or greater size and length;
3. Direct jack installation of pipe or box has been completed within the last two years;
4. List of Project Names and Owners with contact information for projects qualifying the Tunnel specialist.

C Submit manufacturer's literature for product specifications and installation instructions.

D Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 QUALITY ASSURANCE

A The condition for acceptance will be a storm sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A Comply with manufacturer's recommendations.

B Handle pipe, fittings, and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks or trailers. Materials cracked, gouged, chipped, dented, or otherwise damaged will not be approved for installation.

C Store pipe and fittings on heavy timbers or platforms to avoid contact with the ground.

D Unload pipe, fittings, and specials as close as practical to the location of installation to avoid unnecessary handling.

E Keep interiors of pipe and fittings completely free of dirt and foreign matter.

2.0 PRODUCTS

2.01 PIPE MATERIAL

A Reinforced Concrete Box Must be "Jacking Quality" designed to withstand estimated jacking loads; Boxes with an end area greater than 50 square feet should be no longer than six (6) foot in length.

B Joint Cushions: Use ¾" minimum thickness plywood cushions or other approved material; Use cushioning rings of single or multiple pieces.

C Piping materials for storm sewers shall be of the sizes and types indicated on the Plans.

D Materials for pipe and fittings, other than those specified or referenced, may be considered for use in storm sewers.

E For consideration of other materials, submit complete manufacturer's data including materials, sizes, flow carrying capacity, installation procedures, and history of similar installations to Engineer for pre-bid evaluations, if allowed, or as a substitution.

2.02 REINFORCED CONCRETE PIPE

A Circular reinforced concrete pipe shall conform to requirements of ASTM C 76, for Class III wall thickness. Joints shall be rubber gasketed conforming to ASTM C 443.

B Reinforced concrete arch pipe shall conform to the requirements of ASTM C 506 for Class A-III. Joints shall conform to ASTM C 877.

C Reinforced concrete elliptical pipe, either vertical or horizontal, shall conform to the requirements of ASTM C 507 for Class VE-III for vertical or Class HE-III for horizontal. Joints shall be rubber gaskets conforming to ASTM C 877.

D Reinforced concrete D-load pipe shall conform to the requirements of ASTM C 655.

E When approved by the Engineer, high density polyethylene, corrugated drainage pipe meeting requirements of AASHTO M252 or M294 and ASTM D 3350, Hancor or equal.

2.03 PRECAST REINFORCED CONCRETE BOX SEWERS

A All box sewer sections shall conform to ASTM C1433, as indicated on the Plans.

B All pipe and boxes shall be machine-made or cast by a process which will provide for uniform placement of concrete in the forms and compaction by mechanical devices which will assure a dense concrete.

C Concrete shall conform to requirements of Section 03300 – Cast-in-Place Concrete.

D Concrete shall be mixed in a central batch plant or other batching facility from which the quality and uniformity of the concrete can be assured. Transit-mixed concrete is not acceptable.

2.04 CORRUGATED METAL PIPE AND FITTINGS

A Corrugated metal pipe may be galvanized steel, aluminized steel, aluminum or precoated galvanized steel as indicated on Plans and conforming to the following:

Galvanized Steel	AASHTO M218
Aluminized Steel	AASHTO M274
Aluminum	AASHTO M197
Precoated Galvanized Steel	AASHTO M246

1. Reference to gauge of metal is to U.S. Standard Gauge for uncoated sheets. Tables in AASHTO M218 and AASHTO M274 list thicknesses for coated sheets in inches. The tables in AASHTO M197 list thicknesses in inches for clad aluminum sheets.

B Coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to requirements of AASHTO M36 for steel pipe and AASHTO M196 for aluminum pipe.

1. Coupling bands shall be not more than 3 nominal sheet thicknesses lighter than thickness of pipe to be connected and in no case lighter than 0.052 inch for steel or 0.048 inch for aluminum.
2. Coupling bands shall be made of same base metal and coating (metallic or otherwise) as pipe.
3. Minimum width of corrugated locking bands shall be as shown below for corrugations which correspond to end circumferential corrugations on pipes being joined:
   a. 10 ½ inches wide for 2 ⅔ inch x 1/2-inch corrugations.
   b. 12 inches wide for 3 inch x 1 inch corrugations.
4. Helical pipe without circumferential end corrugations will be permitted only when it is necessary to join a new pipe to an existing pipe which was installed with no circumferential end corrugations. In this event pipe furnished with helical corrugations at ends shall be field jointed with either helically corrugated bands or with bands with projections (dimples). The minimum width of helical corrugated bands shall conform to the following:
   a. 12 inches wide for 1/2 inch-deep helical end corrugations.
   b. 14 inches wide for one inch-deep helical end corrugations.

5. Bands with projections shall have circumferential rows of projections with one projection for each corrugation. Width of bands with projections shall be not less than the following:
   a. 12 inches wide for pipe diameters up to and including 72 inches. Bands shall have two circumferential rows of projections.
   b. 16 ¼ inches wide for pipe diameters of 78 inches and greater. Bands shall have four circumferential rows of projections.
6. Bolts for coupling bands shall be 1/2 inch diameter. Bands 12 inches wide or less will have a minimum of 2 bolts per end at each connection, and bands greater than 12 inches wide shall have a minimum of 3 bolts at each connection.
7. Galvanized bolts may be hot dip galvanized in accordance with requirements of AASHTO M 232, mechanically galvanized to provide same requirements as AASHTO M 232, or electro-galvanized per ASTM B 633, Type RS.

C Bituminous coated pipe or pipe arch shall be coated inside and out with a bituminous coating which shall meet these performance requirements and requirements of AASHTO M190.

1. Pipe shall be uniformly coated inside and out to a minimum thickness of 0.05 inch, measured on crests of corrugations.
2. Bituminous coating shall adhere to the metal so that it will not chip, crack, or peel during handling and placement; and shall protect pipe from corrosion and deterioration.
3. Where a paved invert is shown on Plans, pipe or pipe arch, in addition to fully-coated treatment described above, shall receive additional bituminous material, same as specified above, applied to the bottom quarter of circumference to form a smooth pavement. Maintain a minimum thickness of 1/8 inch above crests of corrugations.

D Furnish all fittings and specials required for bends, end sections, branches, access manholes, and connections to other fittings. Design fittings and specials in accordance with Plans and ASTM A 760. Fittings and specials are subject to same internal and external loads as straight pipe.

3.0 EXECUTION

3.01 HYDRAULIC JACKING SYSTEM

1. Has main jacks mounted in jacking frame located in tunneling shaft;
2. Positions jacks at the “haunches” or four corners of the RCB;
3. Has jacking frame which successively pushes string of connected pipes following tunnel excavation towards receiving shaft;
4. Has sufficient jacking capacity to push tunneling shield and string of box through the ground;
5. Has capacity at least 25% percent greater than calculated maximum jacking load;
6. Develops uniform distribution of jacking on end of box by use of a thrust transfer device and plywood cushions or “Kidney Ring”;

7. Use joint cushioning material, use ½ inch minimum thickness for pipe diameter 30 inches or less, use ¾ inch minimum thickness for pipe diameter greater than 30 inches. Use ¾ inch minimum thickness for all boxes.
8. Uses hydraulic jacks which are individually controlled;
9. Uses even pressure to all jacks during operation.

B Box Guides
1. Should be sufficient to support the section of the pipe or box;
2. Should direct the pipe or box on the proper line and grade.

C Tunnel Shield
1. Provides adequate protection for cutters and loaders at the face of the tunnel;
2. Conforms to the shape and size of the pipe or box;
3. May be a half or full shield.

D Ventilation
1. Provide adequate air flow for workers inside the tunnel excavation;
2. Provide equipment with the ability to maintain a reasonable air temperature inside the tunnel excavation.

E Other
1. Use other equipment as necessary to complete box jacking operations including, but not limited to, lighting, air compressor, and mud mixing system.

3.02 SHAFTS

A Shaft
1. Shall be constructed in accordance with the OSHA 1926 standard; Pits should be large enough to accommodate the backstop, jacking equipment, muck removal equipment, and maintain a minimal walking room on either side.
2. Install pipe or box so there is no interference with the operation of street highway, railroad or other facility and no embankment or structure is weakened or damaged.
3. Immediately after installation of pipe or box, backfill shafts or trenches excavated to facilitate jacking, boring or tunneling.

B Backstop
1. Should be constructed to withstand anticipated jacking loads; Constructed out of steel, concrete and/or other approved material.

3.03 JACKING

A Alignment
1. Place the entire jacking assembly in line with the direction and grade of the pipe or box;
2. Jack the pipe or box from the downstream end, whenever possible;
3. The final position of the box must not vary from the line and grade shown on the plans by more than one (1) inch in ten (10) feet;
4. Variation must be regular and in one direction;

5. The final flow must be in the direction shown on the plans.

B Line and Grade Control

1. Use a construction laser to check line and grade after each time the pipe or box is pushed.

C Excavation

1. Excavate the material at the face of the tunnel;
2. Excavation should conform to the shape and size of the pipe or box;
3. The excavation at the bottom of the box should maintain the desired grade of the tunnel;
4. If desired, over excavate to provide not more than two (2) inches of clearance for the upper portion of the box;
5. The distance the excavation extends beyond the end of the pipe or box or Tunnel shield must not exceed two (2) feet;
6. Decrease the distance of the excavation as necessary to maintain stability of the material being excavated;
7. Remove material through the pipe or box;
8. Force the box into the excavated area with the jacking equipment.

D Face Control

1. Provide adequate face control as necessary for the existing soil conditions.

E Box Lubrication

1. Provide and maintain box lubrication system adequate to reduce friction between the pipe or box and the surrounding soil;
2. Use high yield Wyoming bentonite;
3. Lubricate the pipe or box a minimum of twice per work shift;
4. Volume of mud pumped should be sufficient to fill over excavation.

F Work Schedule

1. Maintain a standard work schedule as long as jacking loads allow;
2. As jacking loads increase, increase work schedule;
3. Use a 24 hour, 7 day week operation when necessary.

G Grouting

1. Pressure grout any over excavation of more than one (1) inch.

H Box Repair

1. Repair any box damaged in during jacking operations.
2. Remove and replace any box damaged beyond repair at the Contractor's expense

3.04 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

B In unpaved areas, grade surface as a uniform slope to pre-construction conditions or better or natural grade as indicated on the Plans.

END OF SECTION

Section 02629

SAFETY END TREATMENTS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Safety End Treatments for storm sewers.

B. References to Technical Specifications:

1. Section 01200 - Measurement and Payment Procedures
2. Section 01350 - Submittals
3. Section 01450 - Testing Laboratory Services
4. Section 03300 - Cast-in-Place Concrete
5. Section 02255 - Bedding, Backfill and Embankment Materials
6. Section 02318 - Excavation and Backfill for Utilities
7. Section 02630 - Storm Sewers
8. Section 02631 - Precast Inlets, Headwalls and Wingwalls
9. Section 02633 - Cast-in-Place Inlets, Headwall and Wingwalls

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)
   a. ASTM C 76, "Standard and Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe"

2. Texas Department of Transportation (TX-DOT)
   a. Item 467, Safety End Treatment.

1.02 MEASUREMENT AND PAYMENT

A. Safety End Treatments of all types will be measured by each barrel of each structure end.

B. Payment for Safety End Treatments includes materials, earthwork, connections, and accessories.

C. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make submittals in accordance to Section 01350 - Submittals.

B. Submit manufacturer's literature for product specifications and installation instructions.

1.04 TESTING

A. Testing shall be performed under the provisions in Section 01450 - Testing Laboratory Services.

2.0 PRODUCTS

2.01 MATERIALS

A. Concrete: Class A concrete with minimum compressive strength of 4000 psi.

B. Reinforcing Steel: Conform to requirements of Section 03300 - Cast-in-Place Concrete.

C. Corrugated Metal Pipe: Prefabricated metal end sections.

2.02 PRECAST CONCRETE UNITS

A. Fabricate Precast Units in accordance with Section 02631 - Precast Inlets, Headwalls and Wingwalls.

B. Furnish Precast Concrete Units as indicated on the plans.

C. Provide adequate lifting devices based on size and weight of the unit.

2.03 REINFORCED CONCRETE PIPE

A. Provide RCP mitered to the proposed slope.

B. Reinforced Concrete Pipe shall conform to Section 02630 - Storm Sewers.

2.04 CORRUGATED METAL PIPE

A. Provide galvanized steel prefabricated metal end sections.

B. Corrugated Metal Pipe and Fittings shall conform to Section 02630 - Storm Sewers.

3.0 EXECUTION

3.01 STORAGE AND SHIPMENT

A. Store Precast Units on a level surface.

B. Do not place any loads or ship Precast Units until the design strength is reached.

3.02 CAUSES FOR REJECTIONS

A. Individual Units may be rejected due to fractures, cracks passing through the wall surfaces, surface defects or damages to galvanizing. Remove rejected Units from project and replace with acceptable Units at no additional cost to City.

3.03 EXCAVATION, BEDDING AND BACKFILL

A. Conform to requirements in Section 02318 - Excavation and Backfill for Utilities.

B. Take special precautions in placing and compacting the backfill to avoid any movement or damaged to the Units.

C. Bed Units on foundations of firm and stable material accurately shaped to conform to the Units.

D. Provide adequate means to lift and place the Units.

3.04 CONNECTIONS

A. Make connections to new or existing facilities as needed, at no additional cost to City.

END OF SECTION

Section 02630

STORM SEWERS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Storm sewers and appurtenances.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 03300 – Cast-in-Place Concrete
5. Section 02255 – Bedding, Backfill, and Embankment Materials
6. Section 02318 – Excavation and Backfill for Utilities
7. Section 02415 – Augering Pipe or Casing for Sewers
8. Section 01140 – Contractor's Use of Premises
9. Section 02629 - Safety End Treatments

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM C 76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
b. ASTM C 443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
c. ASTM C 506, "Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe"
d. ASTM C 877, "Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections"
e. ASTM C 507, "Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe"
f. ASTM C 655, "Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe"
g. ASTM D 3350, "Standard Specification for Polyethylene Plastic Pipe and Fittings Materials"
h. ASTM C 1433, "Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers"
i. ASTM B 633, "Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel"
j. ASTM A 760, "Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains"

2. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT

A. Measurement for storm sewers is on a linear foot basis taken along the center line of the pipe from center line to center line of manholes or from end to end of culverts, measured and complete in place. Separate measurement will be made for each type and size of pipe installed.

B. Payment for storm sewer includes pipe, earthwork, connections to existing manholes and pipe, accessories, equipment and execution required are incidental to storm sewer work.

C. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit manufacturer's literature for product specifications and installation instructions.

C. Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 TESTING

A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.05 QUALITY ASSURANCE

A. The condition for acceptance will be a storm sewer that is watertight both in pipe-to-pipe, box-to-box joints and in pipe-to-manhole connections and in box connections.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's recommendations.

B. Handle pipe, fittings, and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks or trailers. Materials cracked, gouged, chipped, dented, or otherwise damaged will not be approved for installation.

C. Store pipe and fittings on heavy timbers or platforms to avoid contact with the ground.

D. Unload pipe, fittings, and specials as close as practical to the location of installation to avoid unnecessary handling.

E. Keep interiors of pipe and fittings completely free of dirt and foreign matter.

2.0 PRODUCTS

2.01 MATERIAL

A. Materials for storm sewers shall be of the sizes and types indicated on the Plans.

B. Materials for pipe and fittings, other than those specified or referenced, may be considered for use in storm sewers.

C. For consideration of other materials, submit complete manufacturer's data including materials, sizes, flow carrying capacity, installation procedures, and history of similar installations to Engineer for pre-bid evaluations, if allowed, or as a substitution.

2.02 REINFORCED CONCRETE PIPE

A. Circular reinforced concrete pipe shall conform to requirements of ASTM C 76, for Class III wall thickness. Joints shall be rubber gasketed conforming to ASTM C 443.

B. Reinforced concrete arch pipe shall conform to the requirements of ASTM C 506 for Class A-III. Joints shall conform to ASTM C 877.

C. Reinforced concrete elliptical pipe, either vertical or horizontal, shall conform to the requirements of ASTM C 507 for Class VE-III for vertical or Class HE-III for horizontal. Joints shall be rubber gaskets conforming to ASTM C 877.

D. Reinforced concrete D-load pipe shall conform to the requirements of ASTM C 655.

2.03 PRECAST AND CAST-IN-PLACE REINFORCED CONCRETE BOX SEWERS

A. All box sewer sections shall conform to ASTM C1433.

B. All pipe and boxes shall be machine-made or cast by a process which will provide for uniform placement of concrete in the forms and compaction by mechanical devices which will assure a dense concrete.

C. Concrete shall conform to requirements of Section 03300 – Cast-in-Place Concrete with minimum compressive strength of 4000 psi.

D. Concrete shall be mixed in a central batch plant or other batching facility from which the quality and uniformity of the concrete can be assured. Transit-mixed concrete is not acceptable.

E. Make test specimens in test cylinders at the same time and in the same manner as the box sections they represent. Make a minimum of 4 test cylinders for each day's production run and each mix design. Cure test cylinders in the same manner and for the same times as the boxes they represent. The producer must furnish all equipment required for testing concrete for boxes produced in a precasting plant.

F. For precast boxes, provide no more than 4 lifting holes in each section. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes of sufficient size for adequate lifting devices based on the size and weight of the box section. Do not use lifting holes larger than 3 in. in diameter. Do not cut more than 1 longitudinal.

G. Rubber gaskted joints for precast reinforced concrete box culverts and sewers may be selected in lieu of boxes with preformed, flexible, mastic gasket material. When rubber gasket joints are selected, they shall meet the requirements of ASTM C 1677 for design of the joints, performance and joint tolerances. When selecting the rubber gasket joint for box, neither filter fabric nor external joint wrap shall be required.

2.04 CORRUGATED METAL PIPE AND FITTINGS

A. Corrugated metal pipe may be galvanized steel, aluminized steel, aluminum or precoated galvanized steel as indicated on Plans and conforming to the following:

Galvanized Steel	AASHTO M218
Aluminized Steel	AASHTO M274
Aluminum	AASHTO M197
Precoated Galvanized Steel	AASHTO M246

1. Reference to gauge of metal is to U.S. Standard Gauge for uncoated sheets. Tables in AASHTO M218 and AASHTO M274 list thicknesses for coated sheets in inches. The tables in AASHTO M197 list thicknesses in inches for clad aluminum sheets.

B. Coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to requirements of AASHTO M36 for steel pipe and AASHTO M196 for aluminum pipe.

1. Coupling bands shall be not more than 3 nominal sheet thicknesses lighter than thickness of pipe to be connected and in no case lighter than 0.052 inch for steel or 0.048 inch for aluminum.

2. Coupling bands shall be made of same base metal and coating (metallic or otherwise) as pipe.

3. Minimum width of corrugated locking bands shall be as shown below for corrugations which correspond to end circumferential corrugations on pipes being joined:

   a. 10 ½ inches wide for 2 ⅔ inch x 1/2-inch corrugations.
   b. 12 inches wide for 3 inch x 1 inch corrugations.

4. Helical pipe without circumferential end corrugations will be permitted only when it is necessary to join a new pipe to an existing pipe which was installed with no circumferential end corrugations. In this event pipe furnished with helical corrugations at ends shall be field jointed with either helically corrugated bands or with bands with projections (dimples). The minimum width of helical corrugated bands shall conform to the following:

   a. 12 inches wide for 1/2 inch-deep helical end corrugations.
   b. 14 inches wide for one inch-deep helical end corrugations.

5. Bands with projections shall have circumferential rows of projections with one projection for each corrugation. Width of bands with projections shall be not less than the following:

   a. 12 inches wide for pipe diameters up to and including 72 inches. Bands shall have two circumferential rows of projections.
   b. 16 ¼ inches wide for pipe diameters of 78 inches and greater. Bands shall have four circumferential rows of projections.

6. Bolts for coupling bands shall be 1/2 inch diameter. Bands 12 inches wide or less will have a minimum of 2 bolts per end at each connection, and bands greater than 12 inches wide shall have a minimum of 3 bolts at each connection.

7. Galvanized bolts may be hot dip galvanized in accordance with requirements of AASHTO M 232, mechanically galvanized to provide same requirements as AASHTO M 232, or electro-galvanized per ASTM B 633, Type RS.

C. Bituminous coated pipe or pipe arch shall be coated inside and out with a bituminous coating which shall meet these performance requirements and requirements of AASHTO M190.

1. Pipe shall be uniformly coated inside and out to a minimum thickness of 0.05 inch, measured on crests of corrugations.

2. Bituminous coating shall adhere to the metal so that it will not chip, crack, or peel during handling and placement; and shall protect pipe from corrosion and deterioration.

3. Where a paved invert is shown on Plans, pipe or pipe arch, in addition to fully-coated treatment described above, shall receive additional bituminous material, same as specified above, applied to the bottom quarter of circumference to form a smooth pavement. Maintain a minimum thickness of 1/8 inch above crests of corrugations.

D. Furnish all fittings and specials required for bends, end sections, branches, access manholes, and connections to other fittings. Design fittings and specials in accordance with Plans and ASTM A 760. Fittings and specials are subject to same internal and external loads as straight pipe.

2.05 PIPE FABRICATION

A. Steel Pipe:

1. Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO M 36, Type I, Type IA, or Type II, as indicated on the Plans.

2. Fabrication with circumferential corrugations, lap joint construction with riveted or spot-welded seams, helical corrugations with continuous helical lock seam, or ultra-high frequency resistance butt-welded seams is acceptable.

B. Aluminum Pipe:

1. Pipe shall conform to the requirements of AASHTO M 196, Type I, Type IA, circular pipe, or Type II, pipe arch as indicated on the Plans.

2. Fabrication with circumferential corrugations, lap joint construction with riveted or spot-welded seams, or helical corrugations with a continuous helical lock seam.

3. Portions of aluminum pipe that will be in contact with concrete or metal other than aluminum, shall be insulated from these materials with a coating of bituminous material meeting requirements of AASHTO M 190. Extend coating a minimum distance of one foot beyond area of contact.

C. Precoated Galvanized Steel Pipe:

1. Pipe shall be full circle or arch pipe conforming to AASHTO M 245, Type I, Type IA or Type II as indicated on the Plans.

2. Fabrication with circumferential corrugations, lap joint construction with riveted seams, or helical lock seams is acceptable.

3. Inside and outside coating shall be a minimum of 10 mils.

2.06 SOURCE QUALITY CONTROL

A. Tolerances: Allowable casting tolerances for concrete units are plus or minus 1/4 inch from dimensions shown on the Plans. Concrete thickness in excess of that required will not constitute cause for rejection provided that such excess thickness does not interfere with proper jointing operations.

B. Precast Unit Identification: Mark date of manufacture and name or trademark of manufacturer clearly on the inside of inlet, headwall or wingwall.

C. Rejection: Precast units may be rejected for non-conformity with these specifications and for any of the following reasons:

1. Fractures or cracks passing through the shell, except for a single end crack that do not exceed the depth of the joint.

2. Surface defects indicating honeycombed or open texture.

3. Damaged or misshaped ends, where such damage would prevent making a satisfactory joint.

D. Replacement: Immediately remove rejected units from the work site and replace with acceptable units.

E. Repairs: Occasional imperfections resulting from manufacture or accidental damage may be repaired if, in the opinion of the Engineer, repaired units conform to requirements of these specifications.

2.07 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

A. Bedding and Backfill Material: Conform to Plans and requirements of Sections 02255 – Bedding, Backfill, and Embankment Materials.

3.0 EXECUTION

3.01 PREPARATION

A. Conform to requirements of Section 02318 – Excavation and Backfill for Utilities, **3.02** "Preparation".

3.02 EARTHWORK

A. Excavate in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities, except where tunneling or jacking methods are shown on the Plans. When pipes are laid in a trench, the trench when completed and shaped to receive the pipe, shall be of sufficient width to provide free working space for satisfactory bedding and jointing and thorough tamping of backfill and bedding material under and around pipe.

B. Bed pipe in accordance with Plans and Specifications. When requested by Engineer, furnish a simple template for each size and shape of pipe for use in checking shaping of bedding. Template shall consist of a thin plate or board cut to match lower half of cross section.

C. Where rock in either ledge or boulder form exists below pipe, remove the rock below grade and replace with suitable materials so that a slightly yielding compacted earth cushion is provided below pipe a minimum of 12 inches thick.

D. Where soil encountered at established grade is quicksand, muck or similar unstable materials, such unstable soil shall be removed and replaced in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities. Do not allow cement stabilized materials for backfill to come into contact with any uncoated aluminum or aluminized pipe surface.

E. After metal pipe structure has been completely assembled on proper line and grade and headwalls constructed when required by the drawing details, place selected material from excavation or borrow along both sides of the completed structures equally, in uniform layers not exceeding 6 inches in depth (loose measurement), wetted if required and thoroughly compacted between adjacent structures and between structure and sides of trench, or for a distance each side of structure equal to diameter of pipe. Backfill material shall be compacted to the same density requirements as specified for adjoining sections of embankment in accordance with specifications. Above three-fourths point of structure, place uniformly on each side of pipe in layers not to exceed 12 inches.

F. Only hand operated tamping equipment will be allowed within vertical planes 2 feet beyond horizontal projection of outside surface of structure for backfilling, until a minimum cover of 12 inches is obtained. Remove and replace damaged pipe.

G. Do not permit heavy earth moving equipment to haul over structure until a minimum of 4 feet of permanent or temporary compacted fill has been placed.

H. During backfilling, obtain uniform backfill material and uniform compacted density throughout length of structure so that unequal pressure will be avoided. Provide proper backfill under structure.

I. Prior to adding each new layer of loose backfill material, an inspection will be made of inside periphery of structure for local or unequal deformation caused by improper construction methods. Evidence of deformation will be reason for such corrective measures as may be directed by Engineer.

3.03 CORRUGATED METAL PIPE INSTALLATION

A. Place pipes on prepared foundation starting at outlet end. Join sections firmly together, with side laps or circumferential joints pointing upstream and with longitudinal laps on sides.

B. Metal in joints which is not protected by galvanizing or aluminizing shall be coated with approved asphaltum paint.

C. Provide proper equipment for hoisting and lowering sections of pipe into trench without damaging pipe or disturbing prepared foundation and sides of trench. Pipe which is not in alignment or which shows undue settlement after laying, or is damaged, shall be taken up and re-laid.

D. Multiple installations of corrugated metal pipe and pipe arches shall be laid with the center lines of individual barrels parallel. Unless otherwise indicated on the Plans, maintain the following clear distances between outer surfaces of adjacent pipes:

DIAMETER OF PIPE	CLEAR DISTANCE BETWEEN PIPES FULL CIRCLE AND PIPE ARCH	PIPE ARCH DESIGN NO.
18”	1’ 2”	2
24”	1’ 5”	3
30”	1’ 8”	4
36”	1’ 11”	5
42”	2’ 2”	6
48”	2’ 5”	7
54”	2’ 10”	8
60” – 84”	3’ 2”	9
90” – 120”	3’ 5”	10 & Over

E. Where extensions are attached to existing structures, install a proper connection between structures and existing as indicated on Plans, coat the connection with bituminous material when required.

F. When existing headwalls and aprons are indicated for reuse on the Plans, sever portion to be reused from the existing culvert, and relocate to prepared position. Damaged

headwalls, aprons or pipes attached to the headwall, shall be restored to their original condition.

3.04 JOINTING

A. Field joints shall maintain pipe alignment during construction and prevent infiltration of side material.

B. Coupling bands shall lap equally on pipes being connected to form a tightly-closed joint.

C. Use corrugated locking bands to field join pipes furnished with circumferential corrugations including pipe with helical corrugations having reformed circumferential corrugations on ends. Fit locking bands into a minimum of one full circumferential corrugation of pipe ends being coupled.

3.05 CONCRETE PIPE INSTALLATION

A. Install in accordance with the Plans and pipe manufacturer's recommendations and as specified in this Section.

B. Install pipe only after excavation is completed, the bottom of the trench shaped, bedding material is installed, and the trench has been approved by the Engineer.

C. Install pipe to the line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in the trench so the interior surfaces of the pipe follow the grades and alignments indicated.

D. Install pipe with the spigot ends toward the direction of flow.

E. Form a concentric joint with each section of adjoining pipe so as to prevent offsets.

F. Place and drive home newly laid sections with come-a-long winches so as to eliminate damage to sections. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by the Engineer.

G. Keep the interior of pipe clean as the installation progresses. Where cleaning after laying the pipe is difficult because of small pipe size, use a suitable swab or drag in the pipe and pull it forward past each joint immediately after the joint has been completed.

H. Keep excavations free of water during construction and until final inspection.

I. When work is not in progress, cover the exposed ends of pipes with an approved plug to prevent foreign material from entering the pipe.

3.06 PRECAST AND CAST-IN-PLACE CONCRETE BOX SEWERS INSTALLATION

A. Placement of Boxes: when precast boxes are used to form multiple barrel structures, place the box sections in conformance with the plans or as directed. Place material to be used between barrels as shown on the plans or as directed. Unless otherwise authorized, start the laying of boxes on the bedding at the outlet end and proceed toward the inlet end with the abutting sections properly matched. Fit, match, and lay the boxes to form a smooth, uniform conduit true to the established lines and grades. For trench installations, lower the box sections into the trench without damaging the box or disturbing the bedding and the sides of the trench. Carefully clean the ends of the box before it is placed. Prevent the earth or bedding material from entering the box as it is laid. Remove and re-lay, without extra compensation, boxes that are not in alignments or that show excessive settlement after laying. Form and place cast-in-place boxes in accordance with Section 03300 - Cast-in-Place Concrete.

B. Connections and Stub Ends: Make connections of boxes to existing boxes, pipes, storm drains, or storm drain appurtenances as shown on the plans. Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Connect boxes to any required headwalls, wingwalls, safety end treatments or riprap, or other structures as shown on the plans or as directed. Repair any damage to the existing structure resulting from making the connections. Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the box.

C. For precast boxes, fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.

3.07 INSTALLATION OTHER THAN OPEN CUT

A. For installation of pipe by augering, boring, or jacking pipe, conform to requirements of Section 02415 - Augering Pipe or Casing for Sewers.

B. Design pipe and box sewers for jacking, boring or tunneling considering the specific installation conditions such as the soil conditions, installation methods, anticipated deflection angles and jacking pressures. When requested, provide design notes and drawings signed by a Texas licensed professional engineer.

3.08 CONNECTIONS

A. Connect inlet leads to the inlets as shown on the Plans. Use non-shrink grout jointing material as shown on the Plans Drawing or as approved. Make connections water tight.

3.09 FINISHES

A. Cut off inlet leads neatly at the inside face of inlet wall. Point up with mortar or field galvanizing.

B. When the box section of the inlet has been completed, shape the floor of the inlet with mortar to conform to the detailed Plans.

C. Finish concrete surfaces in accordance with requirements of Section 03300 – Cast-in-Place Concrete.

3.10 BACKFILL

A. Backfill the trench only after pipe and box sewer installation is approved by the Engineer.

B. Bed pipes with materials conforming to requirements of Section 02318 – Excavation and Backfill for Utilities and as indicated on Plans.

C. Backfill and compact soil in accordance with Section 02318 – Excavation and Backfill for Utilities.

3.11 INSPECTION

A. Remove and replace all nonconforming work at no additional cost to City.

3.12 SAFETY END TREATMENTS (SET)

A. Install safety end treatments in accordance with Section 02629 and as indicated on the plans. Use only approved pre-cast SET's with cross bars.

3.13 CLEAN-UP AND RESTORATION

A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

B. In unpaved areas, grade surface as a uniform slope to natural grade as indicated on the Plans.

END OF SECTION

Section 02631

PRECAST INLETS, HEADWALLS, AND WINGWALLS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete inlets for storm or sanitary sewers, including cast iron frame and plate or grate.

B. Precast concrete headwalls and wingwalls for storm sewers.

C. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01630 – Product Options and Substitution
4. Section 03300 – Cast-in-Place Concrete
5. Section 02542 – Concrete Manholes and Accessories
6. Section 02318 – Excavation and Backfill for Utilities

D. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM C 76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
b. ASTM C 270, "Standard Specification for Mortar for Unit Masonry"

E. Definitions:

1. Normal Depth Type A, Type B, Type C and Type E Inlets - depth of 2.25 feet or less (2' 3") plus pipe inside diameter when measured from grating, bottom of gutter, or throat to flow line of inlet lead.

2. Normal Depth Type BB Inlet - depth of 2.55 feet (2' 6 ⅝ ") plus pipe inside diameter when measured from curb beam to flow line of inlet lead.

3. Extra Depth Inlet - specified depth exceeding normal depth for the type inlet used.

1.02 MEASUREMENT AND PAYMENT

A. Measurement for normal depth inlets is on a per each basis, complete in place.

B. When extra depth is specified on the Plans, measurement for extra depth inlets is on a vertical foot basis for each foot in excess of normal depth, measured and complete in place.

C. Measurement for headwalls and wingwalls is on a per each basis, complete in place.

D. Payment for inlets and for culvert headwalls and wingwalls includes connection of lines, and furnishing and installing frames, grates, rings and covers.

E. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit Shop Drawings for approval of design and construction details for precast concrete inlets, headwalls and wingwalls. .

C. Submit proposals for using equivalent construction products or processes according to Section 01630 – Product Options and Substitution.

D. Submit manufacturer's data and details for frames, grates, rings, and covers.

1.04 STORAGE AND SHIPMENT

A. Store precast units on level blocking. Do not place loads on them until design strength is reached. Shipment of acceptable units may be made when the 28 day strength requirements have been met.

2.0 PRODUCTS

2.01 MATERIALS

A. Concrete: Concrete for precast machine-made units meeting requirements of ASTM C 76 regarding reinforced concrete, cement, aggregate, mixture, and concrete test. Minimum 28-day compressive strength shall be 4,000 psi.

B. Reinforcing steel: Conform to requirements of Section 03300 – Cast-in-Place Concrete. Place reinforcing steel to conform to details shown on Plans and as follows:

1. Provide a positive means for holding steel cages in place throughout production of concrete units. The maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus 1/2 inch whichever is less. Regardless of variation, the minimum cover of concrete over reinforcement as shown on the Plans shall be maintained.

2. Welding of reinforcing steel is not permitted unless noted on the Plans.

C. Mortar: Conform to requirements of ASTM C 270, Type S using Portland cement.

D. Miscellaneous metal: Cast-iron frames and plates conforming to requirements of Section 02542 – Concrete Manholes and Accessories.

2.02 SOURCE QUALITY CONTROL

A. Tolerances: Allowable casting tolerances for concrete units are plus or minus 1/4 inch from dimensions shown on the Plans. Concrete thickness in excess of that required will not constitute cause for rejection provided that such excess thickness does not interfere with proper jointing operations.

B. Precast Unit Identification: Mark date of manufacture and name or trademark of manufacturer clearly on the inside of inlet, headwall or wingwall.

C. Rejection: Precast units may be rejected for non-conformity with these specifications and for any of the following reasons:

1. Fractures or cracks passing through the shell, except for a single end crack that does not exceed the depth of the joint.

2. Surface defects indicating honeycombed or open texture.

3. Damaged or misshaped ends, where such damage would prevent making a satisfactory joint.

D. Replacement: Immediately remove rejected units from the work site and replace with acceptable units.

E. Repairs: Occasional imperfections resulting from manufacture or accidental damage may be repaired if, in the opinion of the Engineer, repaired units according to requirements of these specifications.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify lines and grades are correct.

B. Verify compacted subgrade will support loads imposed by inlets.

3.02 INSTALLATION

A. Install inlets, headwalls, and wingwalls complete in place to the dimensions, lines and grades as shown on the Plans.

B. Excavate in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities.

C. Bed precast concrete units on cement stabilized sand on foundations of firm, stable material accurately shaped to conform to the shape of unit bases.

D. Provide adequate means to lift and place concrete units.

3.03 FINISHES

A. Use a cement-sand mortar mix to seal joints, fill lifting holes, and as otherwise required.

B. When the box section of the inlet has been completed, shape the floor of the inlet with mortar to conform to Plans details.

C. Accurately adjust cast iron inlet plate frames to line, grade, and slope. Grout frame in place with mortar.

3.04 INLET WATERTIGHTNESS

A. Test each inlet for leaks. Verify that inlets are free of visible leaks. Repair leaks in an approved manner.

3.05 CONNECTIONS

A. Connect inlet leads to the inlets as shown on the Plans. Use non-shrink jointing material as shown on the Plans or as approved. Make connections water tight.

3.06 BACKFILL

A. Backfill the area of excavation surrounding each completed inlet, headwall or wingwall according to the requirements of Section 02318 – Excavation and Backfill for Utilities.

END OF SECTION

Section 02632

CAST-IN-PLACE INLETS, HEADWALLS, AND WINGWALLS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Cast-in-place inlets for storm or sanitary sewers, including cast iron frame and plate or grate.

B. Cast-in-place headwalls and wingwalls for storm sewers.

C. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 03300 – Cast-in-Place Concrete
4. Section 02603 – Frames, Grates, Rings, and Covers
5. Section 02318 – Excavation and Backfill for Utilities

D. Referenced Standards:

1. American Society for Testing and Materials (ASTM)
   a. ASTM C 270, "Standard Specification for Mortar for Unit Masonry"

E. Definitions:

1. Normal Depth Type A, Type B, Type C and Type E Inlets - Depth of 2.25 feet or less (2' 3") plus pipe inside diameter when measured from grating, bottom of gutter, or throat to flow line of inlet lead.

2. Normal Depth Type BB Inlet - Depth of 2.55 feet (2' 6⅝") plus pipe inside diameter when measured from curb beam to flow line of inlet lead.

3. Extra Depth Inlet - Specified depth exceeding normal depth for the type inlet used.

1.02 MEASUREMENT AND PAYMENT

A. Measurement for normal depth inlets is on a per each basis, complete in.

B. Measurement for extra depth inlets is on a vertical foot basis for each foot in excess of normal depth, measured and complete in place.

C. Measurement for headwalls and wingwalls is on a per each basis, complete in place.

D. Payment for inlets and for culvert headwalls and wingwalls includes connection of lines and furnishing and installing frames, grates, rings and covers.

E. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit Shop Drawings for approval of design and construction details for cast-in-place units which differ from units shown on Plans.

C. Submit manufacturer's data and details for frames, grates, rings, and covers.

2.0 PRODUCTS

2.01 MATERIALS

A. Concrete: Class A concrete with minimum compressive strength of 4000 psi conforming to requirements of Section 03300 – Cast-in-Place Concrete, unless otherwise indicated on Plans or approved by the Engineer.

B. Reinforcing steel: Conform to requirements of Section 03300 – Cast-in-Place Concrete.

C. Mortar: Conform to requirements of ASTM C 270, Type S using Portland cement.

D. Miscellaneous metals: Cast-iron frames, grates, rings, and covers conforming to requirements of Section 02603 – Frames, Grates, Rings, and Covers.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify lines and grades are correct.

B. Verify compacted subgrade will support loads imposed by inlets.

3.02 INSTALLATION

A. Construct inlets, headwalls, and wingwalls complete in place to the dimensions, lines and grades as shown on Plans.

B. Excavate in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities.

C. The box section of inlet may be constructed of Class A concrete.

D. Forms will be required for both the outside and inside faces of concrete inlet walls, however, if the nature of the material excavated for the inlet is such that it can be hand trimmed to a smooth vertical face, the outside forms may be omitted with approval of the Engineer.

E. Place reinforcing steel to conform to details shown on the Plans. Provide a positive means for holding steel cages in place during concrete placement. Welding of reinforcing steel is not permitted unless noted on the Plans. The maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus 1/2 inch whichever is less. Regardless of variation, the minimum cover of concrete over reinforcement as shown on the Plans shall be maintained.

F. Chamfer exposed edges unless otherwise indicated on Plans.

3.03 FINISHES

A. Cut off inlet leads neatly at the inside face of inlet wall. Point up with mortar.

B. When the box section of the inlet has been completed, shape the floor of the inlet with mortar to conform to the detailed Plans.

C. Finish concrete surfaces in accordance with requirements of Section 03300 – Cast-in-Place Concrete.

3.04 INLET WATERTIGHNESS

A. Verify that inlets are free of visible leaks. Repair leaks in an approved manner.

3.05 BACKFILL

A. Backfill the area of excavation surrounding each completed inlet according to the requirements of Section 02318 – Excavation and Backfill for Utilities.

END OF SECTION

Section 02633

ADJUSTING MANHOLES, INLETS, AND VALVE BOXES

1.0 GENERAL

1.01 SECTION INCLUDES

A Adjusting elevation of manholes, inlets, and valve boxes to new grades.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 03300 – Cast-in-Place Concrete
4. Section 02542 – Concrete Manholes and Accessories
5. Section 02318 – Excavation and Backfill for Utilities
6. Section 02910 – Topsoil
7. Section 02921 – Hydromulch Seeding

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM C 270, "Standard Specification for Mortar for Unit Masonry"

1.02 MEASUREMENT AND PAYMENT

A Measurement for adjusting utility structures to grade is on a lump sum basis for:
1. Adjusting manholes.
2. Adjusting inlets.
3. Adjusting valve boxes.

B Refer to Section 01200 - Measurement and Payment Procedures.

C Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

2.0 PRODUCTS

2.01 CONCRETE MATERIALS

A For cast in place concrete, refer to Section 03300 – Cast-in-Place Concrete.

B For precast concrete manhole sections and adjustment rings, refer to Section 02542 – Concrete Manholes and Accessories.

C For mortar mix, conform to requirements of ASTM C 270, Type S using Portland cement.

2.02 CAST IRON ADJUSTING RINGS

A For cast iron adjusting rings, refer to Section 02542 – Concrete Manholes and Accessories.

2.03 PIPING MATERIALS

A For riser pipes and fittings, refer to applicable piping materials specifications in Sections 02542 – Concrete Manholes and Accessories.

3.0 EXECUTION

3.01 EXAMINATION

A Examine existing structure, valve box, frame and cover or inlet box, frame and cover or inlet, and piping and connections for damage or defects that would affect adjustment to grade. Report such damage or defects to the Engineer.

3.02 ESTABLISHING GRADE

A Coordinate grade related items with existing grade and finished grade or paving, and relate to established bench mark or reference line.

3.03 ADJUSTING MANHOLES AND INLETS

A Elevation of manhole or inlet can be raised using precast concrete rings or metal adjusting rings. Use of brick for adjustment to grade is prohibited. Elevation of manhole or inlet can be lowered by removing existing masonry, adjusting rings or the top section of the barrel below the new elevation and then rebuilding or raising the elevation to the proper height.

B Grout inside and outside adjusting ring joints.

C Salvage and reuse cast iron frame and cover or grate.

D Protect or block off manhole or inlet bottom using wood forms shaped to fit so that no debris or soil falls to the bottom during adjustment.

E Set the cast iron frame for the manhole cover or grate in a full mortar bed and adjust to the established elevation. In streets, adjust covers to be flush to 1/8 inch above pavement.

F Verify that manholes and inlets are free of visible leaks as a result ofreconstruction. Repair leaks in a manner subject to the Engineer's approval.

3.04 ADJUSTING VALVE BOXES

A If usable, salvage and reuse valve box and surrounding concrete block.

B Remove and replace 6 inch ductile iron riser pipe with suitable length for depth of cover required to establish the adjusted elevation to accommodate actual finish grade.

C Reinstall in-kind adjustable valve box and riser piping plumbed in vertical position. Provide minimum 6 inches telescoping freeboard space between riser pipe top butt end and interior contact flange of valve box for vertical movement damping.

D After valve box has been set, aligned, and adjusted so that top lid is level with final grade, pour a 24 inch by 24 inch by 8 inch thick concrete pad around valve box. Center valve box horizontally within concrete slab.

3.05 BACKFILL AND GRADING

A Backfill the area of excavation surrounding each adjusted manhole, inlet, and valve box and compact according to requirements of Section 02318 – Excavation and Backfill for Utilities.

B Grade the ground surface to drain away from each manhole and valve box. Place earth fill around manholes to the level of the upper rim of the manhole frame. Place earth fill around the valve box concrete block.

C In unpaved areas, grade surface at a uniform slope of 1 to 5 from the manhole frame to natural grade. Provide a minimum of 4 inches of topsoil conforming to requirements of Section 02910 – Topsoil and seed in accordance with Section 02921 – Hydromulch Seeding.

END OF SECTION

Section 02634

DUCTILE IRON PIPE AND FITTINGS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Ductile iron pipe and fittings for water mains, wastewater force mains, gravity sanitary sewers, and storm sewers.

B. References to Technical Specifications:

1. Section 01350 – Submittals
2. Section 02676 – Hydrostatic Testing of Pipelines
3. Section 02533 – Sanitary Sewage Force Mains
4. Section 02630 – Polyethylene Wrap
5. Section 02510 – Water Mains
6. Section 02530 – Gravity Sanitary Sewers

C. Referenced Standards:

1. American National Standards Institute (ANSI)

    a. ANSI A21.51, Ductile-Iron Pipe Centrifugal Cast, in Metal Molds
    b. ANSI A21.11, Rubber Gasket Joints Cast and Ductile Iron Press Pipe
    c. ANSI A21.15, Flanged Cast and Ductile Iron
    d. ANSI A21.50, Thickness Design of Ductile Iron Pipe
    e. ANSI A21.10, Cast Iron and Ductile Iron Fittings, 2 thru 48 in./Water
    f. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings
    g. ANSI A21.53, Ductile-Iron Compact Fittings for Water Service
    h. ANSI A21.4, Cement-Mortar lining/Cast and Ductile Iron Pipe and Fittings

2. American Water Works Association (AWWA)

    a. AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
    b. AWWA C110 Ductile-Iron and Gray Iron Fittings for Water
    c. AWWA C153 Ductile-Iron Compact Fittings for Water Service
    d. AWWA C600 Installation for Ductile-Iron Water Mains and Their Appurtenances

3. Steel Structures Painting Council (SSPC)
    a. SSPC-SP 6, Commercial Blast Cleaning

4. American Society for Testing and Materials (ASTM)

a. ASTM G 62, "Standard Test Method for Holiday Detection in Pipeline Coatings"
b. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for ductile iron pipe and fittings under this Section. Include cost in Bid Items for Water Mains, Sanitary Sewage Force Mains, Gravity Sanitary Sewers, and Storm Sewers.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit Shop Drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fitting, flange, and special details. Show station numbers for pipe and fittings corresponding to Plans. Production of pipe and fittings prior to review by the Engineer is at Contractor's risk.

1.04 QUALITY CONTROL

A. Provide manufacturer's certifications that all ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A21.51.

B. Provide certifications that all pipe joints have been tested and meet requirements of ANSI A21.11.

2.0 PRODUCTS

2.01 DUCTILE IRON PIPE

A. Ductile iron pipe barrels: ANSI A21.15, ANSI A21.50 or ANSI A21.51; bear mark of Underwriters' Laboratories approval.

B. Provide pipe sections in standard lengths, not less than 18 feet long, except for special fittings and closure sections as indicated on Shop Drawings.

C. Unless otherwise shown on Drawings, use minimum Pressure Class 250 for waterlines or thickness Class 52 for waterlines in casing or augered hole. Provide minimum thickness Class 52 for sanitary sewers. Provide minimum Pressure Class 350 for flanged pipe.

2.02 JOINTS

A. Joint types: ANSI A21.11 push-on; ANSI A21.11 mechanical joint; or ANSI A21.15 flanged end. Provide push-on joints unless otherwise indicated on the Plans or required by these specifications. For bolted joints, bolts shall conform to requirements of AWWA C111.

B. Where restrained joints for buried service are required by Plans, provide one of the following, or Approved Equal (restrained joints shall be polyethylene wrapped):

1. Super-Lock Joint by Clow Corporation.

2. Flex-Ring or Lok-Ring by American Cast Iron Pipe Company.

3. TR-Flex Joint by U.S. Pipe and Foundry Company.
4. EBAA IRON MEGALUG Mechanical Joint Restraint.

C. Threaded or grooved type joints which reduce pipe wall thickness below minimum required are not acceptable.

D. Provide for restrained joints designed to meet test pressures required under Section 02676 - Hydrostatic Testing of Pipelines or Section 02533– Sanitary Sewage Force Mains, as applicable.

E. Where ductile iron water main is cathodically protected from corrosion, bond rubber gasketed joints as shown on Plans to provide electrical continuity along entire pipeline, except where insulating flanges are required by Plans.

2.03 GASKETS

A. Furnish, when no contaminant is identified, plain rubber (SBR) gasket material; for flanged joints 1/8-inch thick gasket in accordance with ANSI A21.15.

B. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed pipeline, shall have the following gasket materials for the noted contaminants:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber, Nitrile Rubber, FKM Viton Type Gasket (ASTM 1418)
Other contaminants	As recommended by the pipe manufacture

2.04 FITTINGS

A. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they serve.

B. Push-on Fittings will not be allowed above grade.

C. Flanged Fittings: ANSI A21.10; ANSI B16.1 cast or ductile iron. Flanges: ANSI B16.1, Class 125; pressure rated at 250 psig.

D. Mechanical Joint Fittings: ANSI A21.10 (AWWA C110); pressure rated at 250 psi.

E. Ductile Iron Compact Fittings for Water Mains: ANSI A21.53 (AWWA C153); 4-inch through 12-inch diameter; cement-mortar lining; conform to requirements of Section 02630 – Polyethylene Wrap.

2.05 COATINGS AND LININGS

A. Water Main Interiors: ANSI A21.4, cement lined with seal coat.

B. Sanitary Sewer and Force Main Interiors:

1. Preparation: Commercial blast cleaning conforming to SSPC-SP6.

2. Liner thickness: Nominal 40 mils, minimum 35 mils, for pipe barrel interior; minimum 6 - 10 mils at gasket groove and outside spigot end to 6-inches back from end.

3. Testing: ASTM G 62, Method B for voids and holidays; provide written certification.

4. Acceptable Lining Materials:

a. Virgin polyethylene conforming to ASTM D 1248, with inert fillers and carbon black to resist ultraviolet degradation during storage heat bonded to interior surface of pipe and fittings; “Polyline” by American Cast Iron Pipe Company; or Approved Equal.

b. Polyurethane: Corro-pipe II by Madison Chemicals.

c. Ceramic Epoxy: Protecto-401 by Enduron Protective Coatings.

C. Sanitary Sewer Point Repair Pipe: For pipes which will be lined with high density polyethylene liner pipe or cured-in-place liner, provide cement-lined with seal coat in accordance with ANSI A21.4. For pipes which will not be provided with named liner, provide pipe as specified in this Section, 2.05B “Sanitary Sewer and Force Main Interiors”.

D. Exterior: Prime coat and outside asphaltic coating conforming to ANSI A21.10, ANSI A21.15, or ANSI A21.51 for pipe and fittings in open cut excavation and in casings.

E. Polyethylene Wrap: For buried water lines and sanitary sewers, including point repairs, provide polyethylene wrap unless otherwise specified or shown. Provide Polyethylene Wrap for all buried ductile iron pipe, including polyurethane coated pipe.

F. For flanged joints in buried service, provide petrolatum wrapping system, Denso, or Approved Equal, for the complete joint and all alloy steel fasteners. Alternatively, provide bolts made of Type 304 Stainless Steel.

G. Pipe to be installed in potentially contaminated areas shall have coatings and linings recommended by the manufacturer as resistant to the contaminants.

2.06 MANUFACTURERS

A. Pre-approved manufacturers of ductile iron are American Cast Iron Pipe Co., McWane Cast Iron Pipe Co., and U. S. Pipe and Foundry Co.

3.0 EXECUTION

3.01 INSTALLATION

A. Conform to installation requirements of Section 02510 – Water Mains, Section 02530 – Gravity Sanitary Sewers, and Section 02533 – Sanitary Sewage Force Mains, except as modified in this Section.

B. Install in accordance with AWWA C600 and manufacturer's recommendations.

C. Install all ductile iron pipe in polyethylene wrap, unless cathodic protection is provided. Do not use polyethylene wrap with a cathodic protection system.

3.02 GRADE

A. Unless otherwise specified on Plans, install ductile iron pipe for water service to clear utility lines with following minimum cover:

DIAMETER (INCHES)	DEPTH OF COVER (FEET)
16 and 24	5
12 and smaller	4

END OF SECTION

Section 02635

STEEL PIPE AND FITTINGS

1.0 GENERAL

1.01 SECTION INCLUDES

A New steel pipe and fittings for water mains, pumping facilities, and casings.

B References to Technical Specifications:
1. Section 01350 – Submittals
2. Section 02636 – Polyurethane Coatings on Steel or Ductile Iron Pipe
3. Section 02510 – Water Mains

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM A 36, "Standard Specification for Carbon structural Steel"
   b. ASTM A 570, "Standard Practice for Roof System Assemblies Employing Steel Deck, Performed Roof Insulation, and Bituminous Built-Up Roofing"
   c. ASTM A 53, "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless"
   d. ASTM A 135, "Standard Specification for Electric-Resistance-Welded Steel Pipe"
   e. ASTM A 139, "Standard Specification for Electric-Fusion (arc)-Welded Steel Pipe (NPS 4 and Over)"
   f. ASTM C 150, "Standard Specification for Portland Cement"
   g. ASTM C 33, "Standard Specification for Concrete Aggregates"
   h. ASTM D 512, "Standard Test Method for Chloride Ion in Water"
   i. ASTM D 1293, "Standard Test Method for pH of Water"
   j. ASTM D 4541, "Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers"
2. American Water Works Association (AWWA)
   a. AWWA C200 Steel Water Pipe – 6 in. and Larger
   b. AWWA C206 Field Welding of Steel Water Pipe
   c. AWWA M11 Steel Water Pipe: A Guide for Design and Installation, Fourth Edition
   d. AWWA C207 Steel Pipe Flanges for Waterworks Service – Sizes 4 in. Through 144 in.
   e. AWWA C214 Tape Coating Systems for the Exterior of Steel Water Pipelines
   f. AWWA C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

g. AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 in. and Larger – Shop Applied
h. AWWA C602 Cement-Mortar Lining of Water Pipelines in Place-4 in. and Larger
i. AWWA C209 Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

3. American National Standards Institute (ANSI)
4. National Sanitation Foundation (NFS)

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for steel pipe and fittings under this Section. Include cost in Bid Items for water mains, pumping facilities and casings.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit Shop Drawings for aerial crossings and water plant/facilities. Include design of new pipe and fittings indicating alignment and grade, laying dimensions, lining and coating systems, proposed welding procedures, fabrication, fitting, flange, and special details.

C Show station numbers for pipe and fittings corresponding to Plans.

1.04 QUALITY CONTROL

A Provide manufacturer's certifications that all pipe and fittings have been hydrostatically tested at factory in accordance with AWWA C200, Section 3.4.

B Provide manufacturer's affidavits that polyurethane coatings, linings and tape coatings comply with applicable requirements of this Section and that coatings were applied and allowed to cure at a temperature 5 degrees above the dew point.

C Provide manufacturer's affidavits that mortar coatings and linings comply with applicable requirements of this Section and that linings were applied and allowed to cure at a temperature above 32 degrees F.

D Prior to work being started, provide proof of certification of qualification for all welders employed for type of work, procedures and positions involved. Qualifications shall be in accordance with AWWA C206.

E Production of pipe and fittings prior to review by the Engineer shall be at Contractor's risk.

2.0 PRODUCTS

2.01 STEEL PIPE

A Provide steel pipe designed and manufactured in conformance with AWWA C200 and AWWA M11 except as modified herein. Steel shall be minimum of ASTM A 36, ASTM A 570 Grade 36, ASTM A 53 Grade B, ASTM A 135 Grade B, or ASTM A 139 Grade B.

B Minimum Allowable Steel-Wall Thickness: In accordance with following table for HS-20 live loads and depths of bury of up to 16 feet and AWWA C200 new uncoated welded steel.

CASING PIPE
(ENCASEMENT SLEEVES)

CASING PIPE SIZE	MINIMUM WALL		APPROXIMATE WEIGHT PER LINEAR FOOT UNCOATED
	O.D.	THICKNESS	
8”	8.625”	0.219”	19.64
10”	10.75”	0.219”	24.60
12”	12.75”	0.219”	29.28
14”	14.00”	0.219”	32.00
16”	16.00”	0.219”	36.86
20”	20.00”	0.250”	52.73
24”	24.00”	0.250”	63.41
30”	30.00”	0.250”	79.43

C Provide pipe sections in lengths of no less than 20 feet except as required for special fittings or closure sections.

D Fittings: Factory forged for sizes 4 inches through 24 inches; long radius bends; beveled ends for field butt welding; wall thickness: equal to or greater than pipe to which fittings is to be welded; unless otherwise shown on the Plans.

E Joints:

1. Standard field joint for steel pipe; including casings: AWWA C206.
   a. Single-welded, lap joint.
   b. Double-welded, butt joint.
2. Provide mechanically coupled or flanged joints where required for valves and fittings, and as shown on Plans. Flanges: AWWA C207, Class D; same diameter and drilling as Class 125 cast iron flanges, ASA B16.1. Maintain electrically isolated flanged joints between steel and cast iron by using epoxy-

coated bolts, nuts, washers and insulating type gasket unless otherwise approved by Engineer.

F Make curves and bends by use of beveled joints unless otherwise indicated on Plans. Contractor may submit details of other methods of providing curves and bends for consideration by the Engineer. If other methods are deemed satisfactory, install at no additional cost to Owner.

G Provide shop coated and shop lined steel pipe with minimum of one coat of shop applied primer approved for use in potable water transmission on all exposed steel surfaces. Primer for tape coated steel pipe to be used for field-applied coatings shall have no less than 5 percent solids. Provide primer compatible with coating system and in accordance with coating manufacturer's recommendations.

H Standard or Special Sections: Within 1/8 inch + of specified or theoretical lengths. Flanges: Square with pipe with bolt holes straddling both horizontal and vertical axis. Provide 1/2-inch gap between pipe ends where pipe is to be coupled with sleeve couplings.

2.02 EXTERNAL COATING SYSTEMS FOR BURIED STEEL PIPE

A General: Supplied with either tape coatings as specified herein.

1. Tape Coating: AWWA C214; 80-mil, shop-applied, Polyken YG-III, Tek-Rap Yard-Rap, or equal, except as modified herein. Components: primer, one 20-mil layer of inner-layer tape for corrosion protection and two 30-mil layers of outer-layer tape for mechanical protection. Primer: compatible with tape coating, supplied by coating-system manufacturer. Provide pipe with shop coatings cut back from joint ends to facilitate joining and welding of pipe. Taper successive tape layers by 1-inch staggers to facilitate field wrapping of joints. Cut back approximately 4 to 4-1/2 inches to facilitate welding. Inner and outer tape widths:

DIAMETER	TAPE WIDTH
4” – 6”	6”
8” – 12”	9”
14” – 16”	12”
18” – 24”	18”

2.03 EXTERNAL COATING SYSTEM FOR STEEL PIPE IN TUNNEL, CASING OR AUGER HOLES

A Provide exterior coating system of pipe in augered holes or casing, without annular grout, as specified in Section 02636 – Polyurethane Coatings on Steel or Ductile Iron Pipe. No additional exterior coating is required for mortar coated pipe.

2.04 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVEGROUND (OR EXPOSED)

A Provide a 3-coat epoxy/polyurethane coating system as designated below.

Surface Preparation	SSPC SP10 Near White Blast Clean 2.0 to 3.0 mils surface profile
Prime Coat 2.0 to 4.0 mils DFT	ACRO 4422 Inhibitive Epoxy Primer, or approved equal
Intermediate Coat 4.0 to 6.0 mils DFT	ACRO 4460 Chemical Resistant Epoxy, or approved equal
Finish Coat 1.5 to 2.0 mils DFT	ACRO 4428 Polyurethane, or approved equal

B Total minimum allowable dry film thickness for system: 10 mils.

C All materials shall be from same manufacturer.

2.05 INTERNAL LINING SYSTEMS FOR STEEL PIPE

A General: Supply steel pipe with either epoxy lining or shop applied cement mortar lining, capable of conveying water at temperatures not greater than 140ºF. All linings shall conform to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61 and certified by an organization accredited by ANSI. Unless otherwise noted, coat all exposed (wetted) steel parts of flanges, blind flanges, bolts, access manhole covers, etc., with epoxy lining, as specified herein.

B Epoxy Lining: AWWA C210 - White, or approved equal for shop and field joint applied, except as modified herein.

1. Surface Preparation: SSPC-SP-10(64); Near White Blast Clean; 2.0 to 3.0 mils surface profile.
2. Prime Coat: ACRO 4460 NSF Certified Epoxy - Buff; 4.0 to 6.0 mils DFT or approved equal.
3. Intermediate Coat: ACRO 4460 NSF Certified Epoxy - Buff: 4.0 to 6.0 mils DFT or approved equal.
4. Finish Coat: ACRO 4460 NSF Certified Epoxy - White 4.0 to 6.0 mils DFT or approved equal.
5. Minimum allowable dry film system thickness: 12.0 mils.
6. Maximum allowable dry film system thickness: 18.0 mils.
7. Minimum field adhesion: 700 psi.
8. Dry film thicknesses for approved alternate products in accordance with the product manufacturer's recommendations.
9. The lining system may consist of three or more coats of the same approved alternate epoxy lining without the use of a separate primer.

10. Provide materials from the same manufacturer.

C Shop Applied Cement Mortar Lining: AWWA C205; shop-applied, cement mortar linings, except as specified herein 3/8 inch minimum thickness for pipe diameters 24 inches and smaller. Pipe with cut back lining from joint ends no more than 2 inches to facilitate joining and welding of pipe.

2.06 MORTAR FOR EXTERIOR JOINTS

A Cement Mortar: One part cement to two parts of fine, sharp clean sand; mix with water to a consistency of thick cream.

B Portland Cement: ASTM C 150, Type II.

C Sand:
1. Inside joints: AWWA C602; fine graded natural sand.
2. Outside joints: ASTM C 33; natural sand with 100 percent passing No. 16 sieve.

D Water: total dissolved solids less than 1000 mg/l; ASTM D 512 chloride ions less than 100 mg/l for slurry and mortar cure; ASTM D 1293 pH greater than 6.5.

3.0 EXECUTION

3.01 PIPING INSTALLATION

A Conform to applicable provisions of Section 02510 – Water Mains except as modified herein.

3.02 EXTERNAL COATING SYSTEM FOR BURIED STEEL PIPE

A Tape Coating System:
1. Inspect pipe, prior to shipment, for holidays and damage to coating. Perform electrical holiday test of minimum of 6,000 volts with a 60 cycle current audio detector. If test indicates no holidays and outer wrap(s) is torn, remove damaged layers of outer wrap by carefully cutting with sharp razor-type utility knife. Wash with Xylol area to be patched and at least 4 inches of undamaged tape where hand-applied tape wrap will overlap. AWWA C209 cold-applied tape; compatible with tape-wrapping system applied for each layer of outer-wrap tape that has been removed. If damaged area shows holiday when tested, remove outer layers and expose inner wrap. Prime exposed area and overlaps with light coat of primer. Firmly press into place patch of inner wrap of sufficient size to extend 4 inches from holidays in all directions. Holiday test patch to verify that it is installed satisfactorily. Retrim outer layer of tape to expose first wrap of outer-wrap tape sufficiently to allow minimum lap of 2 inches in all directions. Wash exposed outer wrap tape with Xylol and prime. Apply two layers of AWWA C209 outer wrap with 35 mils minimum thickness.

2. Regardless of results of electrical holiday test, bubbles in tape coating system are not allowed. Cut out bubbles and patch as detailed above.
3. Field repairs and applications of coatings: AWWA C209 around joint cutbacks except as modified herein. Field-welded joints: clean shop-primed ends of weld splatter, damaged primer and rust to achieve required surface preparation prior to field repair of linings and coatings.
   a. Immediately prior to placing joint in trench, remove shop-applied primer by abrasive blasting, solvent or other method as approved by the Engineer. Avoid damage to adjacent existing coatings. Clean surfaces to achieve surface preparation at least equivalent to SSPC SP6 in accordance with AWWA C209. Solvent: environmentally safe and compatible with coating-system primer.
   b. Apply primer immediately prior to application of first layer of tape to achieve maximum bond. Apply tape while primer is still "tacky" with 3-inch minimum overlap over shop-applied coating.
4. Do not expose tape coatings to harmful ultraviolet light for more than 90 days. Discard (remove) and replace outer layer of tape coating when exposure exceeds 90 days. In case of factory applied coatings, remove joint from site for removal and reapplication of outer layer of tape coatings.

B At Owner's option, coating system and application may be tested and inspected at plant site in accordance with AWWA C214.

C Cement Mortar Coating: AWWA C205; 1-inch minimum thickness; cut back from joint ends no more than 2 inches to facilitate joining and welding of pipe.

3.03 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVEGROUND, IN VAULTS, TUNNELS OR CASINGS, AND INTERNAL LINING FOR ALL INSTALLATIONS

A Cement Mortar Lining: AWWA C205; 1/2-inch minimum thickness; cut back from joint ends to facilitate joining and welding of pipe.

B Safety: Paints, coatings, and linings specified herein are hazardous materials. Vapors may be toxic or explosive. Protective equipment, approved by appropriate regulatory agency, is mandatory for all personnel involved in painting, coating, and lining operations.

C Workmanship:
1. Application: By qualified and experienced workers who are knowledgeable in surface preparation and application of high-performance industrial coatings.
2. Paint Application Procedures: SSPC Good Painting Practices, Volume 1.

D Surface Preparation:
1. Prepare all surfaces for painting with abrasive blasting.
2. Schedule cleaning and painting so that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Protect surfaces not intended to be painted from effects of cleaning and painting operations.

3. Prior to blasting, clean surfaces to be coated or lined of grease, oil and dirt by steaming or detergent cleaning in accordance with SSPC SP1.
4. Metal and Weld Preparation: Remove all surface defects such as gouges, pits, welding and torch-cut slag, welding flux and spatter by grinding to 1/4-inch minimum radius.
5. Abrasive Material:
   a. Blast only as much steel as can be coated same day of blasting.
   b. Use sharp, angular, properly-graded abrasive capable of producing depth of profile specified herein. Transport abrasive to jobsite in moisture-proof bags or airtight bulk containers. Copper slag abrasives are not acceptable.
   c. After abrasive blast cleaning, verify surface profile with replica tape such as Tes-Tex Coarse or Extra Coarse Press-O-Film Tape, or approved equal. Furnish tapes to Owner for filing and future reference.
   d. Do not blast if metal surface may become wet before priming commences, or when metal surface is less than 5 degrees F above dew point.
6. Remove all dust and abrasive residue from freshly blasted surfaces by brushing or blowing with clean, dry air.

E Coating and Lining Application:

1. Environmental Conditions: Do not apply coatings or linings when metal temperature is less than 50 degrees F; when ambient temperature is less than 5 degrees F above dew point; when expected weather conditions are such that ambient temperature will drop below 40 degrees F within 6 hours after application of coating; or when relative humidity is above 85 percent. Measure relative humidity and dew point by use of sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychometric Tables. Provide dehumidifiers for all field-applied coatings and linings to maintain proper humidity levels.
2. Application Procedures:
   a. Apply coatings and linings in accordance with manufacturer's recommendations and requirements of this Section. Provide a finish free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive overspray or de-laminations.
   b. Thin materials only with manufacturer's recommended thinners. Thin only amount required to adjust viscosity for temperature variations, proper atomization and flow-out. Mix material components using mechanical mixers.
   c. Discard catalyzed materials remaining at end of day.
3. Apply primer immediately after surface has been cleaned. Thoroughly dry pipe before primer is applied. Apply succeeding coats before contamination of under surface occurs.
4. Allow each coat of paint either to dry or cure amount of time recommended by coating or lining manufacturer before successive coats of paint are applied. Apply all successive coats of paint within recoat threshold time as

recommended by coating or lining manufacturer on printed technical data sheets or through written communications.

3.04 INSPECTION

A Procure services of an independent testing laboratory or inspection service, approved by the Engineer, to perform tests on all portions of coating and lining applications. Laboratory shall supply services of NACE Certified Coatings Inspectors having Level III Certification for all coating and linings inspection work. Include cost of such testing in contract unit price bid for water main. Furnish copies of all test reports to the Engineer for review. If defective coatings or lining are revealed, cost of repair and testing of repair will be paid for by Contractor. The Engineer shall have full and final decision as to suitability of all coatings and linings tested.

B For all field applied coatings and linings, including joints, notify Owner sufficiently in advance of work so that Owner can perform examination of and acceptance of surface preparation and application of each coat prior to application of next coat. Furnish appropriate test data to Owner verifying compliance with requirements of this Section of each coat prior to proceeding with next coat. Recoat or repair runs, overspray, roughness and/or abrasives in coating, or other indications of improper application in accordance with coating or lining manufacturer's and the Engineer's instructions.

C Repairs, surface preparation and painting will be subject to inspection by Owner. Guidelines published by Steel Structures Painting Council will be used as basis for acceptance or rejection of cleaning, painting or coating application. SSPC VIS1, Pictoral Surface, along with single-probe magnetic pull-off type dry film thickness gages, electrical holiday detectors, and standard wet film thickness gages will be used to determine acceptability of paint applications.

D Check film thickness with nondestructive magnetic pull-off gage such as Mikrotest Model DFG-100 or electronic thickness gage. National Bureau of Standards certified thickness calibration plates will be used to verify accuracy of thickness gage. Determine maximum and minimum thickness in accordance with SSPC PA2 for frequency and method. Evaluate each length of pipe under SSPC PA2. Consider each field joint area separate and discrete for purpose of DFT measurements. Perform five spot DFT measurements on each field joint area (15 individual readings). Check thickness of each individual coat as well as thickness of overall system with respect to compliance with this Section. Failure to meet either overall system thickness requirements or requirements of component coats shall be cause for rejection and recoat or repair of entire joint or length of pipe.

E Holiday Test:

1. Begin inspection after coating has sufficiently cured, usually one to five days. (Consult coating manufacturer for specific curing schedule.)
2. Use high-voltage d-c holiday detector such as D.E. Stearns Company Model 14/20 or Tinker & Rasor Model AP/W. Use 1600 volts, plus or minus 100 volts. Use brass brush type electrode.

3. Ground high-voltage d-c holiday detector to metal being inspected. Earth-type ground tape is not acceptable. Mark detected defects with white chalk, repair and reinspect.
4. Adhesion Tests: ASTM D 4541; pull-off testing using an Elcometer Model 106 Fixed Alignment Adhesion Tester. Adhesion testing may be directed by the Engineer on any length of pipe or joint which exceeds maximum coating thickness limitations specified in this Section.

3.05 COATINGS AND LININGS INSPECTION

A Owner reserves right to inspect or acquire service of independent third-party inspector who is fully knowledgeable of, and qualified to inspect, surface preparation and application of high-performance coatings to inspect any and all phases of all coatings and linings work, whether field or shop applied. Contractor responsible for application and performance of coating and lining whether or not Owner provides such inspection.

END OF SECTION

Section 02636

POLYURETHANE COATING ON STEEL OR DUCTILE IRON PIPE

1.0 GENERAL

1.01 SECTION INCLUDES

A Two-component polyurethane coating system for use as an internal or external coating for steel or ductile iron pipe.

B References to Technical Specifications:
1. Section 01350 – Submittals
2. Section 02634 - Ductile Iron Pipe and Fittings
3. Section 02635 – Steel Pipe and Fittings

C Referenced Standards:
1. American Water Works Association (AWWA)
   a. AWWA C210, Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
2. American Society for Testing and Materials (ASTM)
   a. ASTM D 16, "Standard Terminology for Paint, Related Coatings, Materials, and Applications"
   b. ASTM D 1737, "Standard Guide for Testing Industrial Water-Reducible Coatings"
3. Steel Structures Painting Council (SSPC)
   a. SSPC-PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges
   b. SSPC-PA 3, A Guide to Safety in Paint Application
   c. SSPC-PS Guide 17.00, Guide for Selecting Urethane Painting Systems
   d. SSPC-SP 1, Solvent Cleaning
   e. SSPC-SP 10, Near-White Blast Cleaning

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for work performed under this Section. Include cost of polyurethane coatings in Bid Items for steel pipe or ductile iron pipe.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit coating manufacturer's catalog sheets and technical information for approval, prior to delivery of pipe.

C Obtain from coating manufacturer and submit a coating "affidavit of compliance" to requirements of this Section stating that coatings were applied in factory and in accordance with manufacturer's minimum requirements.

1.04 SAFETY

A Secure, from manufacturer, Material Safety Data Sheet (MSDS) for polyurethane coatings and repair materials listed in this Section.

B Safety requirements stated in this and related Sections apply in addition to applicable federal, state and local rules and regulations. Comply with instructions of coating manufacturer and requirements of insurance underwriters.

C Follow handling and application practices of SSPC-PA Guide 3; SSPC-PS Guide 17.00; Coating Manufacturer's Material Safety Data Sheet.

1.05 DELIVERY, STORAGE, AND HANDLING

A Use standard containers to prevent gelling, thickening deleteriously or forming of gas in closed containers within period of one year from date of manufacture.

B Label each container of separately packaged component clearly and durably to indicate date of manufacture, manufacturer's batch number, quantity, color, component identification and designated name or formula specification, number of coatings together with special instructions. Do not use coating components older than one year.

C Deliver coating materials to pipe manufacturer in sealed containers showing designated name, batch number, color, date of manufacture and name of coating manufacturer.

D Store materials on site in enclosures which are out of direct sunlight, and in warm, ventilated, and dry area.

E Prevent puncture, inappropriate opening, or other action which may lead to product contamination.

2.0 PRODUCTS

2.01 COATING MATERIAL

A Coating Standard: ASTM D 16.

B Coating System: Use Type V system which is a 2-package polyisocyanate, polyol-cured urethane coating, mixed in 1:1 ratio at time of application. The components shall be balanced viscosities in their liquid state and not require agitation during use.

C Exterior Coating Material: CORROPIPE II-TX and Joint Coating Material CORROPIPE II-PW, manufactured by Madison Chemical Industries, Inc., 5673 Old Dixie Road, Forest Park, Georgia 30050, or approved equal.

D Internal Coating Material: Joint Coating Material CORROPIPE II-PW, manufactured by Madison Chemical Industries, Inc., 5673 Old Dixie Road, Forest Park, Georgia 30050, or approved equal.

E Cured Coating Properties:

1. Conversion to Solids by Volume: 97 percent plus or minus 3 percent.
2. Temperature Resistance: Minus 40 degrees F and plus 130 degrees F.
3. Minimum Adhesion: 500 psi, when applied without primer to ductile iron pipe which has been blasted to comply with SSPC-SP 10.
4. Cure Time: For handling in 1 minute at 120 degrees F, and full cure within 7 days at 70 degrees F.
5. Maximum Specific Gravities: Polyisocyanate resin, 1.20. Polyol resin, 1.15.
6. Minimum Impact Resistance: 80 inch-pounds using 1-inch diameter steel ball where coating is applied at 30 mils to ductile iron pipe surface which has been blasted to SSPC No. 10 finish.
7. Minimum Tensile Strength: 2000 psi.
8. Hardness: 55 plus or minus 5 Shore D at 70 degrees F.
9. Flexibility Resistance: ASTM D 1737 using 1-inch mandrel. Allow coating to cure for 7 days. Perform testing on test coupons held for 15 minutes at temperature extremes specified in this Paragraph.

2.02 REPAIR AND TOUCHUP MATERIAL

A CORROPIPE II PW (two-component, brush applied, or approved equal). Mix in accordance with coating manufacturer's recommendations.

3.0 EXECUTION

3.01 SURFACE PREPARATION

A Remove deposits of oil, grease or other organic contaminates before blast cleaning by using solvent wash as specified in SSPC-PA Guide 3. Clean and dry surfaces making them completely dry, free of moisture, dust, grit, oil, grease or any other deleterious substances prior to application of coating.

B Exterior and Interior Surfaces: SSPC-SP10, near-white metal blast cleaning. The blasting shall be done with clean, hard, sharp cutting abrasives with no steel or cast iron shot in the mix.

C Ductile Iron Pipe: Prior to the start of production blasting, prepare specimens for a white metal blast and a near-white metal blast using the equipment and abrasives proposed for the work. During preparation of the specimens, the blasting intensity and abrasive shall be changed as necessary to provide the degree of cleaning required by SSPC-SP10, except that the color of the blasted substrate is not expected to match the color of blasted steel. After examination and concurrence by the Engineer, the production blasting may begin. Monitor and control the production blasting so that production pipe surfaces match the surface of the approved blasting specimens.

3.02 THICKNESS

A External Coatings: Minimum DFT of 25 mils (0.025 inch).

B Internal Coatings: Minimum DFT of 35 mils.

C Thickness Determinations: Use Type 1 magnetic thickness gauge as described in SSP- PA2 specification. Individual readings below 90 percent of specified minimum are not acceptable. Average individual spot readings (consisting of three point measurements within 3 inches of each other) less than 95 percent of minimum are not acceptable. Average of all spot readings less than minimum thickness specified is not acceptable.

3.03 FACTORY APPLICATION OF POLYURETHANE COATING

A Equipment: Two-component, 1:1 mix ratio, heated airless spray unit.

B Temperature: Minimum 5 degrees F above dew point temperature. The temperature of the surface shall not be less than 60 degrees F during application.

C Humidity: Heating of pipe surfaces may be required to meet the requirements of this Section, 2.01E, “Cured Coating Properties”, if relative humidity exceeds 80 percent.

D Do not thin or mix resins; use as received. Store resins at a temperature above 55 degrees F at all times.

E Application: Conform to coating manufacturer's recommendations. Apply directly to substrate to achieve specified thickness. Multiple-pass, one-coat application process is permitted provided maximum allowable recoat time specified by coating manufacturer is not exceeded.

F Recoat only when coating has cured less than maximum time specified by coating manufacturer. When coating has cured for more than recoat time, brush-blast or thoroughly sand coating surface. Blow-off cleaning using clean, dry, high pressure compressed air.

G Cure at ambient temperature above 0 degrees F. Do not handle pipe until coating has been allowed to cure as follows:

AMBIENT TEMPERATURE	MINIMUM FULL CURE TIME
Over 70 degrees F	7 days
50 to 70 degrees F	9 days
0 to 50 degrees F	12 days

3.04 JOINTS

A Apply coating to unlined pipe surfaces including inside of bell socket and outside of spigot.

B Coating thickness on sealing areas of spigot end of pipe exterior: Minimum 8 mils (0.008 inch), maximum of 10 mils (0.010 inch). Maximum 10 mils may be exceeded in spigot end provided maximum spigot diameter as specified by pipe manufacturer is not exceeded.

3.05 INSPECTION

A Engineer may inspect coatings at coating applicator's facilities.

B Secure approval of surface preparation by coating manufacturer's representative prior to coating application.

C Holiday Inspection: Conform to AWWA C 210, Section 5.3.3.1. Follow coating manufacturer's recommendation. Conduct inspection any time after coating has reached initial cure. Repair in accordance with this Section, 3.07 "Repair and Field Touchup".

3.06 PIPE INSTALLATION

A When required by the Engineer, provide services of manufacturer's representative for period of not less than 2 weeks at beginning of actual pipe laying operations to advise Contractor regarding installation including but not limited to handling and storing, cleaning and inspecting, coatings repairs, and general construction methods as to how they may affect pipe coatings.

B Use nylon straps, padded lifts and padded storage skids. Field cuts should be kept to minimum. Repair damage to coating due to handling or construction practices. Refer to Section 02634 - Ductile Iron Pipe and Fittings and Section 02635 – Steel Pipe and Fittings for additional requirements.

C Just before each section of pipe is to be placed into the trench, conduct a visual and holiday inspection. Defects in the coating system shall be repaired before the pipe is installed.

3.07 REPAIR AND FIELD TOUCHUP

A Apply repair and touchup materials in conformance with factory application of polyurethane coating requirements specified in this Section, excluding equipment requirements.

B Repair Procedure - Holidays:

1. Remove traces of oil, grease, dust, dirt, and other deleterious materials
2. Roughen area to be patched by sanding with rough grade sandpaper (40 grit).

3. Apply one coat of repair material described above. Work repair material into scratched surface by brushing.

C Repair Procedure - Field Cuts or Large Damage:

1. Remove burrs from field cut ends or handling damage and smooth out edge of polyurethane coating.
2. Remove traces of oil, grease, dust, dirt, and other deleterious materials
3. Roughen area to be patched with rough grade sandpaper (40-grit). Feather edges and include overlap of 1 inch to 2 inches of roughened polyurethane in area to be patched.
4. Apply thick coat of repair material described above. Work repair material into scratched surface by brushing. Feather edges of repair material into prepared surface. Cover at least 1 inch of roughened area surrounding damage, or adjacent to field cut.

D Repair Procedure - Thermite Brazed Connection Bonds:

1. Remove polyurethane coating with power wire brush from area on metal surface which is to receive thermite brazed connection.
2. Grind metal surface to shiny metal with power grinder and coarse grit grinding wheel.
3. Apply thermite-brazed connection using equipment, charge and procedure recommended by manufacturer of thermite equipment.
4. After welded surface has cooled to temperature below 130 degrees F, apply protective coating repair material to weld, exposed pipe surface and damaged areas of polyurethane coating.
5. Do not cover or backfill freshly repaired areas of coating at thermite-brazed connection until repair material has completely cured. Allow material to cure in conformance with manufacturer's recommendations.

END OF SECTION

Section 02710

BASE COURSE FOR PAVEMENT

1.0 GENERAL

1.01 SECTION INCLUDES

A. Base course of crushed stone, recycled crushed concrete base, cement-stabilized crushed stone, cement-stabilized bank-run gravel, recycled crushed stone and hot mix asphalt base course.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 - Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 02742 – Prime Coat

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

   a. ASTM C 131, "Standard Test Methods for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine"
   b. ASTM D 4318, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
   c. ASTM C 150, "Standard Specification for Portland Cement"
   d. ASTM C 33, "Standard Specification for Concrete Aggregates"
   e. ASTM D 1557, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort"
   f. ASTM D 1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method"
   g. ASTM D 2922, "Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"
   h. ASTM D 3017, "Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)"

2. Texas Department of Transportation (TxDOT)

   a. Tex-101-E, "Preparing Soil and Flexible Base Materials for Testing"
   b. Tex-110-E, "Particle Analysis of Soils"
   c. Tex-120-E, "Soil-Cement Testing"
   d. Tex-106-E, "Calculating the Plasticity Index of Soils"
   e. Tex-203-F, "Sand Equivalent Test"

f. Tex-126-E, "Molding, Testing, and Evaluating Bituminous Black Base Material"
g. Tex-204-F, "Design of Bituminous Mixtures"
h. Tex-208-F, "Test for Stabilometer Value of Bituminous Material"
i. Tex-227-F, "Theoretical Maximum Specific Gravity of Bituminous Mixtures"
j. Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, 2004 Adoption
   1) Item 340, "Dense-Graded Hot-Mix Asphalt (Method)"

1.02 MEASUREMENT AND PAYMENT

A. Measurement for base course is on a square yard basis. Separate measurement will be made for each different required thickness of base course.

B. When required by Section 01100 – Summary of Work, unit price adjustments shall be made for insufficient in-place depth determined by cores as follows:

1. Adjusted unit price shall be reduced by a ratio of average thickness determined by cores to thickness bid upon, times unit price bid.

2. Adjustment shall apply to lower limit of 90 percent of unit price bid.

C. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit samples of crushed stone, gravel, crushed concrete and soil binder for testing.

C. Submit weight tickets, certified by supplier, with each bulk delivery of cement to work site.

D. Submit manufacturer's description and characteristics for pug mill and associated equipment, spreading machine, and compaction equipment for approval.

E. Submit manufacturing description and characteristics of spreading and finishing machine for approval.

1.04 TESTING

A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the

provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stockpiles shall be made up of layers of processed aggregate materials. Load material by making successive vertical cuts through entire depth of stockpile. Comply with applicable requirements of Section 01600 – Material and Equipment and Section 02255 – Bedding, Backfill, and Embankment Material.

2.0 PRODUCTS

2.01 CRUSHED STONE FLEXIBLE BASE COURSE

A. Crushed Stone: Material retained on the No. 40 Sieve meeting the following requirements:

1. Durable particles of crusher-run broken limestone, sandstone, gravel or granite obtained from an approved source.

2. Los Angeles abrasion test percent of wear not to exceed 40 when tested in accordance with ASTM C 131.

B. Soil Binder: Material passing the No. 40 Sieve meeting the following requirements when tested in accordance with ASTM D 4318:

1. Maximum Liquid Limit: 40.
2. Maximum Plasticity Index: 12.
3. Maximum Lineal Shrinkage: 7 (when calculated from volumetric shrinkage at liquid limit).

C. Mixed Materials shall meet the following requirements:

1. Minimum compressive strength of 35 psi at 0 psi lateral pressure and 175 psi at 15 psi lateral pressure using triaxial testing procedures.

2. Grading in accordance with Tex-101-E and Tex-110-E within the following limits:

SIEVE	PERCENT RETAINED
1 ¾-inch	0 to 10
No. 4	45 to 75
No. 40	60 to 85

2.02 CEMENT STABILIZED BASE COURSE

A. Cement: ASTM C 150 Type I; bulk or sacked.

B. Water: Clean; clear; and free from oil, acids, alkali, or vegetable matter.

C. Crushed Stone: material retained on the No. 40 Sieve meeting the following requirements:

1. Durable particles of crusher-run broken limestone obtained from an approved source.
2. Los Angeles abrasion test percent of wear not to exceed 40 when tested in accordance with ASTM C 131.

D. Gravel: Durable particles of bank-run gravel or processed material.

E. Soil Binder: Material passing the No. 40 Sieve meeting the following requirements when tested in accordance with ASTM D 4318:

1. Maximum Liquid limit: 35.
2. Maximum Plasticity index: 10.

F. Mixed aggregate and soil binder shall meet the following requirements:

1. Grading in accordance with Tex-101-E and Tex-110-E within the following limits:

SIEVE	PERCENT RETAINED			
	CRUSHED STONE	PROCESSED GR. 1	GRAVEL GR. 2	BANKRUN GRAVEL
1 ¾-inch	0 to 10	0 to 5	-	0 to 5
½-inch	-	-	0	-
No. 4	45 to 75	30 to 75	15 to 35	30 to 75
No. 40	55 to 80	60 to 85	55 to 85	65 to 85

2. Obtain prior permission from Engineer for use of additives to meet above requirements.

G. Cut back asphalt: MC30 conforming to requirements of Section 02742 – Prime Coat.

H. Emulsified petroleum resin: EPR-1 Prime conforming to requirements of Section 02742 – Prime Coat.

I. Design mix for minimum average compressive strength of 200 psi at 48 hours using Tex-120-E unconfined compressive strength testing procedures. Provide minimum cement content of 1-1/2 sacks, weighing 94 pounds each, per ton of mix.

J. Increase cement content if average compressive strength of tests on field samples fall below 200 psi. Refer to Part 3 concerning field samples and tests.

K. Mix in stationary pug mill equipped with feeding and metering devices which shall add specified quantities of base material, cement, and water into mixer. Dry mix base material and cement sufficiently to prevent cement balls from forming when water is added.

L. Resulting mixture shall be homogeneous and uniform in appearance.

2.03 CEMENT-STABILIZED RECYCLED CRUSHED CONCRETE BASE (RCCB) COURSE

A. System Description: Provide RCCB with following performance:

1. Minimum 5 percent cement.
2. Minimum Compressive Strength: 650 psi at 7 days following TxDOT Tex-120-E.
3. Prepare concrete product in an on- or off-site pug mill, or in an on- or off-site portable concrete mixer.

B. Preliminary Design: Prepare preliminary mix for 4 cement ratios; 5, 6, 7 and 8 percent.

1. Designate source of concrete for crushing.
2. Results of compression tests will be used by Engineer to select the final mix design.

C. Cement: ASTM C 150 Type I, II or III; bulk or sacked.

D. Water: Potable.

E. Aggregate: Recycled Crushed Concrete: Material retained on the No. 40 Sieve, and durable coarse particles of crusher-run reclaimed cured Portland cement concrete, obtained from an approved source. Organic material is prohibited.

F. Soil Binder (classified below): Meeting the following requirements when tested following TxDOT Tex-106-E:

1. Maximum Liquid Limit: 35
2. Maximum Plasticity Index: 10

G. Mixed Aggregate and Soil Binder: Grading following Tex-101-E and Tex-110-E within the following limits:

SIEVE	PERCENT RETAINED
1 ¾-inch	0 to 10
No. 4	45 to 75
No. 40	55 to 80; classified as "Soil Binder"

1. Obtain prior permission from Engineer for use of additives to meet above requirements.

H. Asphaltic Seal Cure:

1. Use following as Contractor's option to curing by sprinkling, at no additional cost or time.

2. Cut-back asphalt: MC30 following Section 02742 – Prime Coat.

3. Emulsified petroleum resin: EPR-1 Prime following Section 02742 – Prime Coat.

I. Material Mix and Mixing Equipment

1. Design mix for minimum compressive strength of 650 psi at 7 days following Tex-120-E unconfined compressive strength.

2. Cement Ratio: If compressive strength of field samples of installed products fails to meet strength requirements above, increase cement content in one percent increments up to a maximum of 8 percent.

3. Mix according to the requirement s of this Section, 2.03A, with metering devices adding specified quantities of crushed concrete, cement, and water into mixer. Dry mix crushed concrete and cement to prevent cement balls from forming when water is added. Produce homogeneous and uniformly mixed product.

2.04 HOT MIX ASPHALT BASE COURSE (BLACK BASE)

A. Coarse Aggregate: Gravel or crushed stone, or combination thereof that is retained on No. 10 sieve, uniform in quality throughout and free from dirt, organic, or other injurious matter occurring either free or as coating on aggregate. Aggregate shall conform to ASTM C 33 except for gradation. Furnish rock or gravel with Los Angeles abrasion loss not to exceed 40 percent by weight when tested in accordance with ASTM C 131.

B. Fine Aggregate: Sand or stone screenings, or combination thereof, passing No. 10 sieve. Aggregate shall conform to ASTM C 33 except for gradation. Use sand composed of sound, durable stone particles free from loams or other injurious foreign matter. Furnish screenings of same or similar material as specified for coarse aggregate. Plasticity index of that part of fine aggregate passing No. 40 sieve shall be not more than 6 when tested by Tex-106-E. Sand equivalent shall have a minimum value of 45 when tested by Tex-203-F.

C. Composite Aggregate: Conform to the grading limits of TxDOT Item 340 for the paving type indicated on the Plans.

D. Asphaltic Material: Moisture-free homogeneous material which will not foam when heated to 347º F, meeting the following requirements:

VISCOSITY GRADE				
TEST	**AC-10**		**AC-20**	
	min.	**max.**	**min.**	**max.**
Viscosity, 140º F stokes	1000	± 200	2000	± 400
Viscosity, 275º F stokes	1.9	-	2.5	-
Penetration, 77º F, 100 g, 5 sec.	85	-	55	-
Flash Point, C.E.C., F.	450	-	450	-
Solubility in trichloroethylene, percent	99.0	-	99.0	-
Tests on residues from thin film oven tests:				
Viscosity, 140º F stokes	-	3000	-	6000
Ductility, 77º F, 5 cms per min., cms	70	-	50	
Spot tests	Negative for all			

1. Material shall not be cracked.

2. Engineer will designate grade of asphalt to use after design tests have been made. Use only one grade of asphalt after grade is determined by test design for project.

E. Mixing Plant: Weight-batching or drum mix plant with capacity for producing continuously mixtures meeting specifications. Plant shall have satisfactory conveyors, power units, aggregate handling equipment, hot aggregate screens and bins, and dust collectors. Provide equipment to supply materials adequately in accordance with rated capacity of plant and produce finished material within specified tolerances. Following equipment is essential:

1. Cold aggregate bins and proportioning device
2. Dryer
3. Screens

4. Aggregate weight box and batching scales
5. Mixer
6. Asphalt storage and heating devices
7. Asphalt measuring devices
8. Truck scales

F. Bins: Separate aggregate into minimum of four bins to produce consistently uniform grading and asphalt content in completed mix.

G. Mix: Employ and pay certified testing laboratory to prepare design mixes. Test in accordance with Tex-126-E, Tex-204-F, Tex-208-F, and Tex-227-F.

H. Density and Stability Requirements:

PERCENT DENSITY		PERCENT OPTIMUM	HVEEM STABILITY PERCENT NOT LESS THAN
MIN	MAX		
95	99	97	35

I. Proportions for Asphaltic Material: As specified in TxDOT Item 340 for the mix type shown on the Plans.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade is ready to support imposed loads.

B. Verify lines and grades are correct.

3.02 PLACEMENT

A. Do not mix and place cement stabilized base when temperature is below 40º F and falling. Base may be placed when temperature taken in shade and away from artificial heat is above 35º F and rising.

B. Place material on prepared subgrade in uniform layers to produce thickness indicated on Plans. Depth of layers shall not exceed 8 inches. Do not dump material in piles or windrows.

C. Spread with approved spreading machine. Conduct spreading so as to eliminate planes of weakness or pockets of non-uniformly graded material resulting from hauling and dumping operations.

D. Provide construction joints between new material and stabilized base that has been in place 4 hours or longer. Joints shall be approximately vertical. Form joint with a temporary header or make vertical cut of previous base immediately before placing subsequent base.

E. Use only one longitudinal joint at center line under main lanes and shoulder. Do not use longitudinal joints under frontage roads and ramps.

F. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Secure a firm bond between reinforcement and base.

G. Do not place asphaltic base when air temperature is below 50 F and falling. Base may be placed when air temperature taken in shade and away from artificial heat is above 40 F and rising.

H. Haul prepared and heated asphaltic concrete mixture to project in tight vehicles previously cleaned of foreign material. Mixture shall be at temperature between 250º F and 325º F when laid.

I. Spread material into place with approved mechanical spreading and finishing machine of screening or tamping type. Use track-mounted finish machine to place base course directly on earth subgrade.

J. Place base courses 4 inches or greater in thickness in two or more layers, each having compacted thickness of not greater than 4 inches. Spread all lifts. Attain smooth course of uniform density to section, line and grades as indicated on Plans.

K. Place courses as nearly continuously as possible. Pass roller over unprotected ends of freshly laid mixture only when mixture has become cooled. When work is resumed, cut back laid material to produce slightly beveled edge for full thickness of course. Remove old material which has been cut away and lay new mix against fresh cut.

L. When new asphalt/concrete is laid against existing asphalt, existing asphalt/concrete shall be saw cut full depth to provide straight smooth joint.

M. In restricted areas where use of paver is impractical, spread and finish asphalt by mechanical compactor. Use wood or steel forms, rigidly supported to assure correct grade and cross section. Carefully place materials to avoid segregation of mix. Do not broadcast material. Remove any lumps that do not break down readily. Place asphalt courses in same sequence as if placed by machine.

3.03 COMPACTION

A. Start compaction as soon as possible but not more than 60 minutes from start of moist mixing. Compact loose mixture with approved tamping rollers until entire depth is uniformly compacted. Do not allow stabilized base to mix with underlying material.

B. Correct irregularities or weak spots immediately by replacing material and recompacting.

C. Apply water to maintain moisture between optimum and 3 percent above optimum moisture as determined by ASTM D 1557. Mix in with a spiked tooth harrow or equal. Reshape surface and lightly scarify to loosen imprints made by equipment.

D. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.

E. Finish by blading surface to final grade after compacting final course. Seal with approved pneumatic tired rollers which are sufficiently light to prevent surface hair line cracking. Rework and recompact at areas where hair line cracking develops.

F. Compact to minimum density of 95 percent of modified Proctor density at a moisture content of treated material between optimum and 3 percent above optimum as determined by ASTM D 1557, unless otherwise indicated on the Plans.

G. Maintain surface to required lines and grades throughout operation.

3.04 CURING

A. Moist cure for minimum of 7 days before adding pavement courses. Restrict traffic on base to local property access. Keep subgrade surface damp by sprinkling.

B. If indicated on Plans, cover base surface with a curing membrane as soon as finishing operation is complete. Apply with approved self-propelled pressure distributer at following rates, or as indicated on Plans:

1. MC30: 0.1 gallon per square yard.
2. EPR-1 Prime: 0.15 gallon per square yard.

C. Do not use cutback asphalt during the period of April 16 to September 15.

3.05 TOLERANCES

A. Completed surface shall be smooth and conform to typical section and established lines and grades.

B. Top surface of base course: Plus or minus 1/4 inch in cross section, or in 16 foot length.

3.06 FIELD QUALITY CONTROL

A. At the direction of the Engineer, a minimum of one core will be taken at random locations per 1,000 linear feet per lane of roadway or 500 square yards of base to determine in-place depth.

B. Contractor may, at his own expense, request additional cores in the vicinity of cores indicating nonconforming in-place depths. If the average of the tests falls below the required depth, place and compact additional material at no cost to the Owner.

C. Compaction Testing will be performed in accordance with ASTM D 1556 or ASTM D 2922 and ASTM D 3017 at a random location near each depth determination core. Rework and recompact areas that do not conform to compaction requirements at no additional cost to the Owner.

D. Fill cores and density test sections with new compacted cement stabilized base.

3.07 NONCONFORMING PAVEMENT

A. Recompact pavement sections not meeting specified densities or replace them with new asphaltic concrete material. Replace with new material, sections of base course not meeting surface test requirements or having unacceptable surface texture. Patch asphalt pavement sections in accordance with procedures established by Asphalt Institute.

B. Remove and replace areas of asphaltic concrete base course found by cores to be deficient in thickness by more than 10 percent at no cost to Owner. Use new asphaltic concrete base material of thickness shown on Plans.

C. Areas of asphaltic concrete base course found by cores to be deficient in thickness by less than 10 percent shall be remedied at the Owner's direction by one of the following methods:

1. Remove and replace using new asphaltic concrete base material of thickness shown on Plans and in accordance with the requirements of this Section at no cost to Owner.

2. Reduce the Unit Price by the ratio of the average thickness (as determined by cores) to the thickness required.

D. No adjustments will be made for excess thickness.

3.08 PROTECTION OF THE WORK

A. Maintain stabilized base in good condition until completion of work. Repair defects immediately by replacing base to full depth.

B. Protect the asphalt membrane, if used, from being picked up by traffic. The membrane may remain in place when proposed surface courses or other base courses are to be applied.

END OF SECTION

Section 02741

ASPHALTIC CONCRETE PAVEMENT

1.0 GENERAL

1.01 SECTION INCLUDES

A. Surface courses of compacted mixture of coarse and fine aggregates and asphaltic material.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 - Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 02742 – Prime Coat
5. Section 02743 – Tack Coat

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

    a. ASTM C 33, “Standard Specification for Concrete Aggregates”
    b. ASTM C 131, “Standard Test Methods for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”

2. Texas Department of Transportation (TxDOT)

    a. Tex-106-E, “Calculating the Plasticity Index of Soils”
    b. Tex-203-F, “Sand Equivalent Test”
    c. Tex-126-E, “Molding, Testing, and Evaluating Bituminous Black Base Material”
    d. Tex-204-F, “Design of Bituminous Mixtures”
    e. Tex-208-F, “Test for Stabilometer Value of Bituminous Material”
    f. Tex-207-F, “Determining Density of Compacted Bituminous Mixtures”
    g. Tex-227-F, “Theoretical Maximum Specific Gravity of Bituminous Mixtures”
    h. Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, 2004 Adoption
        1) Item 340, “Dense-Graded Hot-Mix Asphalt (Method)”

1.02 MEASUREMENT AND PAYMENT

A. Measurement for asphaltic concrete pavement is on square yard basis. Separate measurement will be made for each different required thickness of pavement.

B. Payment for asphaltic concrete pavement includes all labor and materials required to complete placement as indicated on Plans.

C. Refer to Section 01200 – Measurement and Payment Procedures.

D. Refer to this Section, 3.07 "Noncomforming Pavement" for unit price adjustments for deficient thickness.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit certificates that asphaltic materials and aggregates meet requirements of this Section.

C. Submit proposed design mix and test data for each type and strength of surface course in Work.

D. Submit manufacturer's description and characteristics of mixing plant for approval.

E. Submit manufacturer's description and characteristics of spreading and finishing machine for approval.

1.04 TESTING

A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

2.0 PRODUCTS

2.01 MATERIALS

A. Coarse Aggregate: Crushed stone or gravel or combination thereof, that is retained on No. 10 sieve, uniform in quality throughout and free from dirt, organic or other injurious matter occurring either free or as coating on aggregate. Aggregate shall conform to ASTM C 33 except for gradation. Furnish rock or gravel with Los Angeles

abrasion loss not to exceed 40 percent by weight when tested in accordance with ASTM C 131.

B. Fine Aggregate: Sand or stone screenings or combination of both passing No. 10 sieve. Aggregate shall conform to ASTM C 33 except for gradation. Use sand composed of sound, durable stone particles free from loams or other injurious foreign matter. Furnish screenings of same or similar material as specified for coarse aggregate. Plasticity index of that part of fine aggregate passing No. 40 sieve shall be not more than 6 when tested by Tex-106-E. Sand equivalent shall have a minimum value of 45 when tested by Tex-203-F.

C. Composite Aggregate: Conform to the grading limits of TxDOT Item 340 for the paving type indicated on the Plans.

D. Asphaltic Material: Moisture-free homogeneous material which will not foam when heated to 347º F, meeting following requirements:

VISCOSITY GRADE				
TEST	**AC-10**		**AC-20**	
	MIN.	**MAX.**	**MIN.**	**MAX.**
Viscosity, 140º stokes	1000	±200	2000	±400
Viscosity, 275º stokes	1.9	-	2.5	-
Penetration, 77º, 100 g, 5 sec.	85	-	55	-
Flash Point, C.O.C., F.	450	-	450	-
Solubility in trichloroethylene, percent	99.0	-	99.0	-
Tests on residues from thin film oven tests:				
Viscosity, 140º stokes	-	3000	-	6000
Ductility, 77º, 5 cms per min., cms	70	-	50	-
Spot tests	Negative for all grades			

1. Material shall not be cracked.
2. The Engineer will designate grade of asphalt to use after design tests have been made. Use only one grade of asphalt after grade is determined by test design for project.

2.02 EQUIPMENT

A. Mixing Plant: Weight-batching or drum mix plant with capacity for producing continuously mixtures meeting specifications. Plant shall have satisfactory conveyors, power units, aggregate handling equipment, hot aggregate screens and bins, and dust

collectors. Provide equipment to supply materials adequately in accordance with rated capacity of plant and produce finished material within specified tolerances. Following equipment is essential:

1. Cold aggregate bins and proportioning device.
2. Dryer.
3. Screens.
4. Aggregate weight box and batching scales.
5. Mixer.
6. Asphalt storage and heating devices.
7. Asphalt measuring devices.
8. Truck scales.

B. Bins: Separate aggregate into minimum of four bins to produce consistently uniform grading and asphalt content in completed mix.

2.03 MIXES

A. Employ and pay certified testing laboratory to prepare design mixes. Test in accordance with Tex-126-E or Tex-204-F and Tex-208-F.

B. Density and Stability Requirements:

PERCENT DENSITY		PERCENT OPTIMUM	HVEEM STABILITY PERCENT NOT LESS THAN
MIN.	MAX.		
95	99	97	35

C. Proportions for Asphaltic Material: As specified in TxDOT Item 340 for the paving type shown on the Plans.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify compacted base course is ready to support imposed loads.

B. Verify lines and grades are correct.

3.02 PREPARATION

A. Prime Coat: If indicated on the Plans, apply a prime coat conforming to requirements of Section 02742 – Prime Coat. Do not apply a tack coat until primed base has cured to satisfaction of the Engineer.

B. Tack Coat: Conform to requirements of Section 02743 – Tack Coat. Where the mixture will adhere to the surface on which it is to be placed without use of a tack coat, tack coat may be eliminated if approved by the Engineer.

C. Do not use cutback asphalt during the period of April 16 to September 15.

3.03 PLACEMENT

A. Do not place asphaltic mixture in rain or when air temperature is below 50º F and falling. Mixture may be placed when air temperature taken in shade and away from artificial heat is above 40°F and rising.

B. Haul prepared and heated asphaltic concrete mixture to the project in tight vehicles previously cleaned of foreign material. Mixture shall be at temperature between 250º F and 325º F when laid.

C. Spread material into place with approved mechanical spreading and finishing machine of screening or tamping type. Use track-mounted finish machine to place base course directly on earth subgrade.

D. Surface Course Material: Surface course 2 inches or less in thickness may be spread in one lift. Spread all lifts in such manner that, when compacted, finished course will be smooth, of uniform density, and will be to section, line and grade as shown. Coincide construction joints on surface courses with lime lines, or as directed by the Engineer.

E. Place courses as nearly continuously as possible. Pass roller over unprotected ends of freshly laid mixture only when mixture has cooled. When work is resumed, cut back laid material to produce slightly beveled edge for full thickness of course. Remove old material which has been cut away and lay new mix against fresh cut.

F. When new asphalt is laid against existing or old asphalt mat, existing or old asphalt shall be saw cut full depth to provide straight smooth joint.

G. In restricted areas where use of paver is impractical, spread and finish asphalt by mechanical compactor. Use wood or steel forms, rigidly supported to assure correct grade and cross section. Carefully place materials to avoid segregation of mix. Do not broadcast material. Remove any lumps that do not break down readily. Place asphalt courses in same sequence as if placed by machine.

3.04 COMPACTION

A. Begin rolling while pavement is still hot and as soon as it will bear roller without undue displacement or hair cracking. Keep wheels properly moistened with water to prevent adhesion of surface mixture. Do not use excessive water.

B. Compress surface thoroughly and uniformly, first with power-driven, 3-wheel, or tandem rollers weighing from 8 to 10 tons. Obtain subsequent compression by starting at side and rolling longitudinally toward center of pavement, overlapping on successive trips by at least one-half width of rear wheels. Make alternate trips slightly different in length. Continue rolling until no further compression can be obtained and all rolling marks are eliminated. Complete all rolling before mixture temperature drops below 175° F.

C. Use tandem roller for final rolling. Double coverage with approved pneumatic roller on asphaltic concrete surface is acceptable after flat wheel and tandem rolling has been completed.

D. Along walls, curbs, headers and similar structures, and in all locations not accessible to rollers, compact mixture thoroughly with lightly oiled tamps.

E. Compact binder course and surface course to density not less than 93 percent of the maximum possible density of voidless mixture composed of same materials in like proportions.

3.05 TOLERANCES

A. Furnish templates for checking surface in finished sections. Maximum deflection of templates, when supported at center, shall not exceed 1/8 inch.

B. Completed surface, when tested with 10-foot straightedge laid parallel to center line of pavement, shall show no deviation in excess of 1/8 inch in 10 feet. Correct any surface not meeting this requirement.

3.06 FIELD QUALITY CONTROL

A. At the direction of the Engineer, minimum of one core may be taken at random locations per 1,000 feet per lane of roadway or 500 square yards of asphalt concrete pavement to determine in-place depth and density.

B. In-place density will be determined in accordance with Tex-207-F and Tex-227-F from cores or sections of asphaltic base located near each core. Other methods of determining in-place density, which correlate satisfactorily with results obtained from roadway specimens, may be used when approved by the Engineer.

C. Contractor may, at his own expense, request three additional cores in vicinity of cores indicating nonconforming in-place depths. In-place depth at these locations shall be average depth of four cores.

D. Fill cores and density test sections with new compacted asphaltic concrete pavement.

3.07 NONCONFORMING PAVEMENT

A. Recompact pavement sections not meeting specified densities or replace them with new asphaltic concrete material. Replace with new material sections of surface course pavement not meeting surface test requirements or having unacceptable surface texture. Patch asphalt pavement sections in accordance with procedures established by Asphalt Institute.

B. Remove and replace areas of asphaltic concrete pavement found by cores to be deficient in thickness by more than 10 percent at no cost to Owner. Use new asphaltic concrete pavement of thickness shown on Plans.

C. Areas of asphaltic concrete pavement found by cores to be deficient in thickness by less than 10 percent shall be remedied at the Owner's direction by one of the following methods:

1. Remove and replace using new asphaltic concrete pavement of thickness shown on Plans and in accordance with the requirements of this Section at no cost to Owner.

2. Reduce the Unit Price by the ratio of the average thickness (as determined by cores) to the thickness required.

D. No adjustments will be made for excess thickness.

3.08 PROTECTION OF THE WORK

A. Do not open pavement to traffic until 12 hours after completion of rolling, or as shown on Plans.

B. Maintain asphaltic concrete pavement in good condition until completion of Work.

C. Repair defects immediately by replacing asphaltic concrete pavement to full depth at no cost to Owner.

END OF SECTION

Section 02742

PRIME COAT

1.0 GENERAL

1.01 SECTION INCLUDES

A. Prime coat for asphaltic concrete paving

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for prime coat under this Section. Include cost in Bid Items for which this Work is a component.

B. If prime coat is included as a Bid Item, measurement will be based on the units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit product data for proposed prime coat.

C. Submit report of recent calibration of distributor.

2.0 PRODUCTS

2.01 CUTBACK ASPHALT

A. Provide moisture-free homogeneous material which will not foam when heated to 347º F and which meets following requirements:

1. Asphalt material for prime coat shall be MC-30 or MC-70 and shall meet following requirements:

TYPE-GRADE PROPERTIES	MC-30		MC-70	
	MIN.	MAX.	MIN.	MAX.
Water, percent	---	0.2	---	0.2
Flash Point, T.O.C., ºF	100	---	100	---
Kinematic Viscosity at 140º F, cst	30	60	70	140

2. Distillate shall be as follows, expressed as percent by volume of total distillate to 680º F:

	MC-30		MC-70	
	MIN.	MAX.	MIN.	MAX.
to 437º F	---	25	---	20
to 500º F	40	70	20	60
to 600º F	75	93	65	90
Residue from 680º F Distillation,				
Volume, percent	50	---	55	---

3. Tests on Distillation Residue:

	MC-30		MC-70	
	MIN.	MAX.	MIN.	MAX.
Penetration at 77º F, 100g, 5 sec.	120	250	120	250
Ductility at 77º F, 5 cm/min. cms	100*	---	100*	---
Solubility in trichloroethylene, %	99	---	99	---
Spot Test	All Negative			
* If penetration of residue is more than 200 and ductility at 77º F is less than 100 cm, material will be acceptable if its ductility at 60º F is more than 100.				

2.02 EMULSIFIED PETROLEUM RESIN

A. EPR-1 Prime: Slow curing emulsion of petroleum resin and asphalt cement conforming to the following requirements:

PROPERTIES	MIN.	MAX.
Fural Viscosity at 77 º F, sec	14	40
Residue by Evaporation, % by weight	60	-
Sieve Test, %	-	0.1
Particle Charge Test	Positive	
Tests on the Distilation Residue:		
Flash Point, COC (F)	400	-
Kinematic Viscosity @ 140 º F (cSt)	190	350

B. For use, EPR-1 may be diluted with water up to a maximum of three parts water to one part EPR-1 in order to achieve the desired concentration of residual resin/asphalt and facilitate application.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify base is ready to support imposed loads.

B. Verify lines and grades are correct.

3.02 PREPARATION

A. Thoroughly clean base course surface of loose material by brooming prior to application of prime coat.

B. Prepare sufficient base in advance of paving for efficient operations.

3.03 APPLICATION, GENERAL

A. Apply prime coat with approved type of self-propelled pressure distributor. Distribute prime coat evenly and smoothly under pressure necessary for proper distribution.

B. Keep all storage tanks, piping, retorts, booster tanks and distributors used in handling asphaltic materials clean and in good operating conditions. Conduct operations so that asphaltic material does not become contaminated.

C. If yield of asphaltic material appears to be in error, recalibrate distributor prior to continuing Work.

D. Maintain the surface until Work is accepted by Owner.

3.04 APPLICATION, CUTBACK ASPHALT

A. Do not use cutback asphalt during the period of April 16 to September 15.

B. Do not place prime coat in rain or when air temperature is below 60º F and falling. Materials may be placed when air temperature taken in shade and away from artificial heat is above 50º F and rising.

C. Distribute at rate of 0.25 to 0.35 gallons per square yard.

D. Provide all necessary facilities for determining temperature of asphaltic material in all heating equipment and in distributor, for determining rate of application, and for obtaining uniformity at junction of two distributor loads. Provide and maintain in good working order, recording thermometer at storage heating unit at all times.

E. Temperature of application shall be based on temperature-viscosity relationship that will permit application of asphalt with viscosity of 100 to 125 centistokes. Maintain asphalt within 15º F of temperature required to meet viscosity. Selected temperature shall be within following range:

PRIME COAT TYPE	MINIMUM (º F)	MAXIMUM (º F)
MC-30	70	150
MC70	125	175

F. Do not allow temperature of MC-30 to exceed 175º F at any time.

G. Do not allow temperature of MC-70 to exceed 200º F at any time.

3.05 APPLICATION, EMULSIFIED PETROLEUM RESIN

A. Do not place prime coat in rain or when air temperature is below 36º F and falling.

B. Distribute at rate of 0.15 to 0.25 gallons per square yard.

3.06 PROTECTION OF THE WORK

A. No traffic or placing of subsequent courses shall be permitted over freshly applied prime coat until authorized by the Engineer.

END OF SECTION

Section 02743

TACK COAT

1.0 GENERAL

1.01 SECTION INCLUDES

A. Tack coat for asphaltic concrete paving.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 - Submittals

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)
   a. ASTM D 244, "Standard Test Methods and Practices for Emulsified Asphalts"

1.02 MEASUREMENT AND PAYMENT

A. Unless indicated as a Bid Item, no separate payment will be made for tack coat under this Section. Include cost in Bid Items for which this Work is a component.

B. If tack coat is included as a Bid Item, measurement will be based on the units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit product data for proposed tack coat.

C. Submit report of recent calibration of distributor.

2.0 PRODUCTS

2.01 CUTBACK ASPHALT

A. Provide moisture-free, homogeneous material which will not foam when heated to 347° F and which meets following requirements:

1. Asphalt material for tack coat: RC-250 and meet following:

PROPERTIES	MIN.	MAX.
Water, percent	---	0.2
Flash Point, T.O.C., ºF	80	---
Kinematic Viscosity at 140º F, cst	250	400

2. Distillate: Expressed as percent by volume of total distillate to 680° F:

	MIN	MAX
to 437º F	40	75
to 500º F	65	90
to 600º F	85	---
Residue from 680º F Distillation		
Volume, percent	70	---

3. Tests on Distillation Residue:

	MIN.	MAX
Penetration at 77º F, 100g, 5 sec.	100	150
Ductility at 77º F, 5 cms	100	---
Solubility in trichloroethylene, %	99	---
Spot Test	All Negative	

2.02 EMULSION

A. Provide homogeneous material which shall show no separation of asphalt after mixing and shall meet the viscosity requirements at any time within 30 days after delivery.

1. Emulsion material for tack coat: SS-1 and meet following:

	MIN.	MAX
Furol Viscosity at 77º F, sec.	30	100
Residue by Distillation, %	60	---
Oil Portion of Distillate, %	---	2
Sieve Test, %	---	0.1
Miscibility (Standard Test)	Passing	Passing
Cement Mixing, %	---	2.0
Storage Stability, 1 Day, %	---	1
Test on Residue:		
Penetration at 77º F, 100 g, 5 sec	120	160
Solubility in Trichloroethylene, %	97.5	---
Ductility at 77º F, 5 cm/min, cms	100	---

2. For emulsions used for tack coats during the period of April 16 to September 15, volatile organic compound solvents (VOC) shall not exceed 12% by weight when tested in accordance with ASTM D 244.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify compacted base is ready to support imposed loads.

B. Verify lines and grades are correct.

3.02 PREPARATION

A. Thoroughly clean base course or concrete surface of loose material by brooming prior to application of tack coat.

3.03 APPLICATION

A. Apply tack coat uniformly by use of approved distributor at rate not to exceed 0.05 gallons per square yard of surface.

B. Paint all contact surfaces of curbs and structures, and all joints with thin uniform coat of tack coat.

C. Cutback Asphalt:

1. Do not use cutback asphalt during the period of April 16 to September 15.

2. Do not place tack coat in rain or when air temperature is below 50° F and falling. Materials may be placed when air temperature taken in shade and away from artificial heat is above 40° F and rising.

3. Temperature of tack coat shall be between 125° F and 180° F when applied.

4. Do not heat tack coat above 200° F at any time.

3.04 PROTECTION OF THE WORK

A. No traffic or placing of subsequent courses shall be permitted over freshly applied tack coat until authorized by the Engineer.

END OF SECTION

Section 02744

SINGLE COURSE SURFACE TREATMENT

1.0 GENERAL

1.01 SECTION INCLUDES

A A wearing surface, also known as Seal Coat or Chip-Seal, composed of a single application of asphaltic material, covered with aggregate, constructed on a prepared surface or base course.

B References to Technical Specifications:
1. Section 01100 – Summary of Work
2. Section 01200 – Measurement and Payment Procedures
3. Section 01350 – Submittals
4. Section 02980 – Pavement Repair

C Referenced Standards:
1. Texas Department of Transportation (TxDOT)
   a. Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, 2004 Adoption
      1) Item 300, "Asphalts, Oils, and Emulsions"
      2) Item 302, "Aggregates for Surface Treatments"
      3) Item 316, "Surface Treatments"
      4) Item 210, "Rolling"

1.02 MEASUREMENT AND PAYMENT

A Measurement for Single Course Surface Treatment is on square yard basis, measured and completed in place. Payment includes materials, equipment, preparation, and work associated with the application of the Surface Treatment.

B Unless indicated as a Bid Item, no separate payment will be made for repair of failed or defective areas of pavement prior to resurfacing.

C If paving repair is included as a Bid Item, measurement is on a square yard basis. The limits are as defined in Section 01100 – Summary of Work, or as shown on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 - Submittals.

B Submit test results and certifications that asphaltic materials and aggregates meet requirements of this Section prior to use.

C Submit manufacturer's description and characteristics of aggregate spreading and finishing machine(s) for approval.

D Submit calibration report of emulsion distributor. The requirement of this submittal may be waived by Engineer when a computer controlled distributor is used.

2.0 PRODUCTS

2.01 EMULSION

A Asphaltic material shall conform to the requirements of TxDOT, Item 300, "Asphalts, Oils, and Emulsions".

B The asphaltic material shall be Grade CRS-1P or CRS-2P
1. The CRS-1P shall be a rapid setting, cationic emulsion for use in placing surface treatments when the air temperature is between 40°F and 70°F.
2. The CRS-2P shall be a rapid setting, cationic emulsion for use in placing surface treatments when the air temperature is 60°F and rising.

C The emulsion shall break and cure in a reasonable amount of time when the aggregate is applied, regardless of sunlight or humidity conditions.

2.02 AGGREGATE

A Aggregate material shall conform in type, grade, classification, and quality to the requirements of TxDOT, Item 302, "Aggregates for Surface Treatments". Samples submitted for testing shall be taken from stockpiles located on the Project Site.

B Stockpile aggregate separately. Take necessary steps to prevent stockpiles from being contaminated. Do not add materials to approved stockpiles without the Engineer's approval.

C When tested by TxDOT, Tex-200-F, Part 1, the aggregate gradation shall meet the requirements in the table below for the specified grade:

Aggregate Gradation Requirements
(Cumulative % Retained)

SIEVE SIZE	GRADE 3	GRADE 4
¾ in	0	
⅝ in	0 – 2	0
½ in	20 – 40	0 – 5
⅜ in	80 – 100	20 – 40
¼ in	95 – 100	–
#4	–	95 – 100
#8	99 – 100	98 – 100

2.03 EQUIPMENT

A Equipment used in each phase of application shall conform to the requirements of TxDOT, Article 316.3 "Equipment".

3.0 EXECUTION

3.01 EXAMINATION

A Verify compacted base or prepared surface is ready to support imposed loads.

B Verify lines and grades are correct.

3.02 PREPARATION

A All holes, ruts, depressions, or other defects in the surface shall be repaired and defective areas cleaned out by scarifying or acceptable hand methods under the provisions of Section 02980 – Pavement Repair.

B Fill defects with new material of the same character, or other materials approved by the Engineer, the road surface shall be compacted by rolling or tamping so that a smooth, hard, well cemented surface, conforming to the lines, grade, and typical cross-section shown on the plans is secured.

C After the patches have been allowed to set-up under traffic, sweep the surface of the roadway clean from dirt, dust, and other deleterious matter by means of mechanical, rotary street sweeper, hand brooms, or compressed air.

D Before any asphaltic material is applied, all cakes of dust or clay and all foreign matter shall be removed and the surface thoroughly cleaned until the embedded aggregate is cleaned but not discharged or loosened.

E The surface may be lightly sprinkled just prior to application of the asphalt if found necessary by the Engineer.

3.03 APPLICATION

A Air temperature shall be taken in the shade and away from artificial heat.
1. Treatment may be applied when air temperature is above 40°F and rising.
2. Do not apply treatment when air temperature is below 50°F and falling.
3. Do not apply treatment when roadway surface temperature is below 60°F.
4. When, in the opinion of the Engineer, general weather conditions are not suitable, do not apply treatment.

B When Grade 3 aggregate is specified, the asphaltic material shall be applied on the prepared surface at a rate of approximately 0.35 gallons per square yard.

C When Grade 4 aggregate is specified, the asphaltic material shall be applied on the prepared surface at a rate of approximately 0.30 gallons per square yard.

D When Type B (crushed gravel, crushed slag, crushed stone, or limestone rock asphalt) aggregate is specified, the rate of spread shall be one cubic yard to each 90 square yards of surface area.

E When Type PB (precoated crushed gravel, crushed slag, crushed stone, or limestone rock asphalt) aggregate is specified, the rate of spread shall be one cubic yard to each 95 square yards of surface area.

F The surface shall be thoroughly rolled as soon as aggregate is applied with a self-propelled light, pneumatic roller in accordance with applicable sections of TxDOT, Item 316, "Surface Treatment" and TxDOT, Item 210, "Rolling".

G The Contractor shall repair all fatty areas with additional cover material and all lean areas by adding asphalt to the extent that a uniformly dense treatment is finally obtained. Should depressions, unevenness, or irregular spots develop on the surface, they shall be remedied and the surface brought to true grade and cross-section.

H The surface shall be broomed to remove excess aggregate as soon as aggregate has sufficiently bonded. Brooming shall be repeated the following work day.

3.04 PROTECTION OF THE WORK

A No traffic or placing of subsequent courses shall be permitted over freshly applied tack coat until authorized by the Engineer.

B Contractor is responsible for maintaining Single Course Surface Treatment until Owner accepts the Work.

END OF SECTION

Section 02751

CONCRETE PAVEMENT

1.0 GENERAL

1.01 SECTION INCLUDES

A Portland Cement Concrete Pavement for Concrete Streets, Driveways and Sidewalks; Joints and Curing Materials.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM C 150, "Standard Specification for Portland Cement"
   b. ASTM C 94, "Standard Specification for Ready-Mixed Concrete"
   c. ASTM C 33, "Standard Specification for Concrete Aggregates"
   d. ASTM C 131, "Standard Test Methods for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine"
   e. ASTM C 136, "Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates"
   f. ASTM C 40, "Standard Test Method for Organic Impurities in Fine Aggregates for Concrete"
   g. ASTM C 260
   h. ASTM C 494, "Standard Specification for Chemical Admixtures for Concrete"
   i. ASTM A 615, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"
   j. ASTM D 994, "Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)"
   k. ASTM D 1751, "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Type)
   l. ASTM D 6690, "Standard Specification for Joint and Crack Sealants, Hot-Applied, for Concrete and Asphaltic Pavements"
   m. ASTM C 39, "Standard Test Method for Compressive Strength of Concrete"
   n. ASTM C 31, "Standard Practice for Making and Curing Concrete Test Specimens in the Field"
   o. ASTM C 143, "Standard Test Method for Slump of Hydraulic Cement Concrete"

p. ASTM C 138, "Standard Test Method for Density (Unit Weight),Yield, and Air Content (Gravimetric) of Concrete"
q. ASTM C 231,"Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method"
r. ASTM C 171, "Standard Specification for Sheet Materials for Curing Concrete"
s. ASTM C 309, "Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete"
t. ASTM C 42, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete"

2. Texas Department of Transportation (TxDOT)
   a. Tex-406-A, "Material Finer than 75-µm (No. 200) Sieve in Mineral Aggregates (Decantation Test for Concrete Aggregates)
   b. Tex-203-F, "Sand Equivalent Test"
   c. Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, 2004 Adoption
      1) Item 438 "Cleaning and Sealing Joints and Cracks (Rigid Pavements and Bridge Decks)"

1.02 MEASUREMENT AND PAYMENT

A Measurement for concrete paving is on square yard basis. Separate measurement will be made for each different required thickness of pavement.

B Payment includes all labor and materials required for installation of concrete paving, joints and curing material, as indicated on Plans.

C Refer to Section 01200 – Measurement and Payment Procedures.

D Refer to this Section, 3.26 "Noncomforming Pavement" for unit price adjustments for deficient thickness.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals. Submittals shall conform to requirements of Section 01350 - Submittals.

B Submit proposed mix design and test data for each type and strength of concrete in Work. Include proportions and actual compressive strength obtained from design mixes at required test ages.

C Submit manufacturer's description and characteristics for mixing equipment, and for traveling form paver, if proposed for use, for approval.

D Submit manufacturer's certificates giving properties of reinforcing steel. Provide specimens for testing when required by the Engineer.

E Submit product data for joint sealing compound and proposed sealing equipment for approval.

F Submit samples of dowel cup, metal supports, and deformed metal strip for approval.

1.04 HANDLING AND STORAGE

A Do not mix different classes of aggregate without written permission of the Engineer.

B Class of aggregate being used may be changed before or during Work with written permission of the Engineer. New class shall comply with specifications.

C Segregated aggregate will be rejected. Before using aggregate whose particles are separated by size, mix them uniformly to grading requirements.

D Aggregates mixed with dirt, weeds or foreign matter will be rejected.

E Do not dump or store aggregate in roadbed.

2.0 PRODUCTS

2.01 MATERIALS

A Portland Cement:
1. Sample and test cement to verify compliance with Standards of ASTM C 150, Type I or Type III.
2. Bulk cement which meets referenced standards may be used if the method of handling is approved by the Engineer. When using bulk cement, provide satisfactory weighing devices.

B Water: Conform to requirements for water in ASTM C 94.

C Coarse Aggregate: Gravel or crushed stone, or combination thereof, which is clean, hard, durable, conforms to requirements of ASTM C 33, and has abrasion loss not more than 45 percent by weight when subjected to Los Angeles Abrasion Test (ASTM C 131). No pit run gravel will be allowed.
1. Maximum percentage by weight of deleterious substances shall not exceed following values:

ITEM	PERCENT BY WEIGHT OF TOTAL SAMPLE MAXIMUM
Clay lumps and friable particles.	3.0
Material finer than 75-µm (No. 200) sieve:	
Concrete subject to abrasion.	3.0*

All other concrete.	5.0*
Coal and lignite:	
Where surface appearance of concrete is of importance.	0.5
All other concrete.	1.0

* In case of manufactured sand, if material finer than 75-µm (No. 200) sieve consists of dust of fracture, essentially free from clay or shale, these limits may be increased to 5 and 7 percent, respectively.

2. Coarse aggregate (size 1 1/2 inch to No. 4 sieve) shall conform to requirements of ASTM C 33. Gradation shall be within following limits when graded in accordance with ASTM C 136:

SIEVE DESIGNATION (SQUARE OPENINGS)	(PERCENTAGE BY WEIGHT)
Retained on 1 3/4 inch sieve	0
Retained on 1 1/2 inch sieve	0 to 5
Retained on 3/4 inch sieve	30 to 65
Retained on 3/8 inch sieve	70 to 90
Retained on No. 4 sieve	95 to 100
Loss by Decantation Test	
*Method Tex-406-A	1.0 maximum

* In case of aggregates made primarily from crushing of stone, if material finer than 200 sieve is dust of fracture essentially free from clay or shale as established by Part III of Tex-406-A, percent may be increased to 1.5

D Fine Aggregate: Sand, manufactured sand, or combination thereof, composed of clean, hard, durable, uncoated grains, free from loams or other injurious foreign matter. Fine aggregate for concrete shall conform to requirements of ASTM C 33. Gradation shall be within following limits when graded in accordance with ASTM C 136:

SIEVE DESIGNATION (SQUARE OPENINGS)	(PERCENTAGE BY WEIGHT)
Retained on 3/8 inch sieve	0
Retained on No. 4 sieve	0 to 5
Retained on No. 8 sieve	0 to 20
Retained on No. 16 sieve	15 to 50
Retained on No. 30 sieve	35 to 75
Retained on No. 50 sieve	65 to 90

Retained on No. 100 sieve	90 to 100
Retained on No. 200 sieve	97 to 100

1. When subjected to color test for organic impurities (ASTM C 40), fine aggregate shall not show color darker than standard color. Fine aggregate shall be subjected to Sand Equivalent Test (Tex-203-F). Sand equivalent value shall not be less than 80, unless higher value is shown on Plans.

E Air Entraining Agent: Furnish an air entraining agent conforming to requirements of ASTM C 260.

F Water Reducer: Water reducing admixture conforming to requirements of ASTM C 494 may be used if required to improve the workability of concrete. Amount and type of such admixture shall be subject to approval by the Engineer.

G Reinforcing Steel:

1. Provide new billet steel manufactured by open hearth process and conforming to ASTM A 615, Grade 60. Store steel to protect it from mechanical injury and rust. At time of placement, steel shall be free from dirt, scale, rust, paint, oil or other injurious materials.
2. Cold bend reinforcing steel to shapes shown. Once steel has been bent, it may not be rebent.

2.02 CONCRETE JOINTS

A When allowed on the Plans, or with approval of the Engineer, Board Expansion Joint Material may be used: Filler board of selected stock. Use wood of density and type as follows:

1. Clear, all-heart cypress weighing no more than 40 pounds per cubic foot, after being oven dried to constant weight.
2. Clear, all-heart redwood weighing no more than 30 pounds per cubic foot, after being oven dried to constant weight.
3. Use wood only when part of a load transmission device assembly.

B Unless specified otherwise, use Preformed Expansion Joint Material: Bituminous fiber and bituminous mastic composition material conforming to ASTM D 994 and ASTM D 1751.

C Joint Sealing Compound:

1. Hot poured rubber-asphalt compound meeting the requirements of ASTM D 6690.
2. When indicated on Plans, self-leveling Low Modulas Silicone sealant single component meeting the requirements of TxDOT Specification 438.

D Load Transmission Devices:

1. Smooth, steel dowel bars conforming to ASTM A 615, Grade 60. When indicated on Plans, encase one end of dowel bar in approved cap having inside diameter 1/16 inch greater than diameter of dowel bar.
2. Deformed steel tie bars conforming to ASTM A 615, Grade 60.

E Metal Supports for Reinforcing Steel and Joint Assembly: Employ metal supports of approved shape and size that will secure reinforcing steel and joint assembly in correct position during placing and finishing of concrete. Space supports as directed by the Engineer.

2.03 EQUIPMENT

A Equipment: Conform to requirements of ASTM C 94.

2.04 MIXING

A Employ and pay certified testing laboratory to prepare mix designs. Compressive strength shall be as specified using test specimens prepared in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Contractor shall determine and measure batch quantity of each ingredient, including all water for batch designs and all concrete produced for Work. Mix shall conform to these specifications and other requirements indicated on Plans.

B Mix design to produce concrete which will have a minimum compressive strength of 2500 psi at 7days and 3500 psi at 28 days. When high-early-strength cement is used, it shall reach a minimum compressive strength of 3500 psi at 7 days and 4000 at 28 days. Slump of concrete shall be at least 2 inch, but no more than 5 inches, when tested in accordance with ASTM C 143.

1. Concrete pavement shall contain at least 5 1/2 sacks (94 pounds per sack) of cement per cubic yard, with not more than 6.5 gallons of water, net, per sack of cement (water cement ratio maximum 0.57). Cement content shall be determined in accordance with ASTM C 138. Addition of mineral filler may be used to improve workability or plasticity of concrete to limits specified.
2. Coarse dry aggregate shall not exceed 85 percent of loose volume of concrete.
3. Add air-entraining admixture to ensure uniform distribution of agent throughout batch. Base air content of freshly mixed air-entrained concrete upon trial mixes with materials to be used in Work, adjusted to produce concrete of required plasticity and workability. Percentage of air entrainment in mix shall be 4 1/2 percent plus or minus 1 1/2 percent. Air content shall be determined by testing in accordance with ASTM C 231.
4. Use retardant when temperature exceeds 90 degrees F. Proportion shall be as recommended by manufacturer. Use same brand as used for air-entraining agent. Add and batch material using same methods as used for air-entraining agent. Accelerators will not be allowed unless approved by the Engineer.

2.05 COVER MATERIALS FOR CURING

A Curing materials shall conform to one of following:

1. Polyethylene Film: Opaque pigmented white film conforming to requirements of ASTM C 171.
2. Waterproofed Paper: Paper conforming to requirements of ASTM C 171.
3. Cotton Mats: Single layer of cotton filler completely enclosed in cover of cotton cloth. Mats shall contain not less than 3/4 of a pound of uniformly distributed cotton filler per square yard of mat. Cotton cloth used for covering materials shall weigh not less than 6 ounces per square yard. Mats shall be stitched so that mat will contact surface of pavement at all points when saturated with water.
4. Liquid Membrane-forming Compounds: Liquid membrane-forming compounds shall conform to ASTM C 309. Membrane shall restrict loss of water to not more than 0.55 kg/m^2 of surface in 72 hours.

3.0 EXECUTION

3.01 EXAMINATION

A Verify compacted base is ready to support imposed loads and meets compaction requirements.

B Verify lines and grades are correct.

3.02 PREPARATION

A Properly prepare, shape and compact each section of subgrade before placing forms, reinforcing steel or concrete. After forms have been set to proper grade and alignment, use subgrade planer to shape subgrade to its final cross section. Check contour of subgrade with template.

B Remove subgrade that will not support loaded form. Replace and compact subgrade to required density.

3.03 EQUIPMENT

A Alternate equipment and methods, other than those required by this article, may be used provided the Contractor demonstrates that equal, or better, results will be obtained. Maintain equipment for preparing subgrade and for finishing and compacting concrete in good working order. Unless approved otherwise by the Engineer or the Plans, slip form paving methods shall be used.

B Subgrade Planer and Template:

1. Use subgrade planer with adjustable cutting blades to trim subgrade to exact section shown on Plans. Select planer mounted on visible rollers which ride on forms. Planer frame must have sufficient weight so that it will remain on form

at all times, and have such strength and rigidity that, under tests made by changing support from wheels to center, planer will not develop deflection of more than 1/8 inch. Tractors used to pull planer shall not produce ruts or indentations in subgrade. When slip form method of paving is used, operate subgrade planer on prepared track grade or have it controlled by electronic sensor system operated from string line to establish horizontal alignment and elevation of subbase.

2. Provide template for checking contour of subgrade. Template shall be long enough to rest upon side forms and have such strength and rigidity that, when supported at center, maximum deflection shall not exceed 1/8 inch. Fit template with accurately adjustable rods projecting downward at 1 foot intervals. Adjust these rods to gauge cross sections of slab bottom when template is resting on side forms.

C Texturing Equipment

1. Carpet Drag
   a. Provide a carpet drag mounted on a work bridge or a moveable support system. Provide a single piece of carpet of sufficient transverse length of carpet is in contact with the concrete being placed to produce the desired texture.

D Machine Finisher: Provide a power-driven, transverse finishing machine designed and operated to strike off and consolidate concrete. Machine shall have two screeds accurately adjusted to crown of pavement and with frame equipped to ride on forms. Use finishing machine with rubber tires if it operates on concrete pavement.

E Hand Finishing:

1. Provide mechanical strike and tamping template 2 feet longer than width of pavement to be finished. Shape template to pavement section.
2. Provide two bridges to ride on forms and span pavement for finishing expansion and dummy joints. Provide floats and necessary edging and finishing tools.

F Vibrators: Furnish mechanically operated synchronized vibrators mounted on tamping bar which rides on forms and hand-manipulated mechanical vibrators. Furnish vibrators with frequency of vibration to provide maximum consolidation of concrete without segregation.

3.04 FORMS

A Side Forms: Use clean metal forms of approved shape and section. Preferred depth of form shall be equal to required edge thickness of pavement. Forms with depths greater or less than required edge thickness of pavement will be permitted, provided difference between form depth and edge thickness if not greater than 1 inch, and further provided that forms of depth less than pavement edge are brought to required edge thickness by securely attaching wood or metal strips to bottom of form, or by grouting under form.

Bottom flange of form shall be same size as thickness of pavement. Aluminum forms are not allowed. All forms shall be approved by the Engineer. Length of form sections shall be not less than 10 feet and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200 foot radius or less. Forms shall have ample strength and shall be provided with adequate devices for secure setting so that when in-place they will withstand, without visible springing or settlement, impact and vibration of finishing machine. In no case shall base width be less than 8 inches for form 8 inches or more in height. Forms shall be free from warp, bends or kinks and shall be sufficiently true to provide reasonable straight edge on concrete. Top of each form section, when tested with straight edge, shall conform to requirements specified for surface of completed pavement. Provide sufficient forms for satisfactory placement of concrete. For short radius curves, forms less than 10 feet in length or curved forms may be used. For curb returns at street intersections and driveways, wood forms of good grade and quality may be used.

B Form Setting:

1. Rest forms directly on subgrade. Do not shim with pebbles or dirt. Accurately set forms to required grade and alignment and, during entire operation of placing, compacting and finishing of concrete, do not deviate from this grade and alignment more than 1/8 inch in 10 feet of length. Do not remove forms for at least 8 hours after completion of finishing operations. Provide supply of forms that will be adequate for orderly and continuous placing of concrete. Set forms and check grade for at least 300 feet ahead of mixer or as approved by the Engineer.
2. Adjacent slabs may be used instead of forms, provided that concrete is well protected from possible damage by finishing equipment. These adjacent slabs shall not be used for forms until concrete has aged at least 7 days.

3.05 REINFORCING STEEL AND JOINT ASSEMBLIES

A Accurately place reinforcing steel and joint assemblies and position them securely as indicated on Plans. Wire reinforcing bars securely together at intersections and splices. Bars and coatings shall be free of rust, dirt or other foreign matter when concrete is placed. Place all reinforcing steel and secure to chairs. All reinforcing steel must be positively supported before pour begins.

B Place pavement joint assemblies at required locations and elevations, and rigidly secure all parts in required positions. Install dowel bars accurately in joint assemblies as shown, each parallel to pavement surface and to center line of pavement. Rigidly secure in required position to prevent displacement during placing and finishing of concrete. Accurately cut header boards, joint filler and other material used for forming joints to receive each dowel bar. Drill dowels into existing pavement, secure with epoxy, and provide paving headers, as required, to provide rigid pavement sections.

3.06 PLACEMENT

A Place concrete only in rain-free days when air temperature taken in shade and away from artificial heat is above 35 degrees F and rising. Concrete shall not be placed when temperature is below 40 degrees F and falling.

Place concrete that is between 40 degrees F and 95 degrees F at the time of discharge. Do not exceed 60 minutes between introduction of cement to the aggregates and discharge. When the weather is such that the concrete temperature would exceed 90 degrees F, employ effective means, such as pre-cooling of aggregates and mixing water, using ice or placing at night, as necessary to maintain concrete temperature, as placed, below 95 degrees F. Do not place when concrete temperature is above 95 degrees F at the time of discharge.

B Place concrete within 60 minutes of mixing. Remove and dispose of concrete not placed within this period.

C Concrete slump during placement shall be 2 to 5 inches, except when using traveling-form paver slump shall be a maximum of 3 inches.

D Deposit concrete rapidly and continuously on subgrade or subbase in successive batches. Distribute concrete to required depth and for entire width of placement in manner that will require as little rehandling as possible. Where hand spreading is necessary, distribute concrete with shovels or by other approved methods. Use only concrete rakes in handling concrete. At end of day or in case of unavoidable interruption of more than 30 minutes, place transverse construction joint at point of stopping work. Remove and replace sections less than 10 feet long.

E Take special care in placing and spading concrete against forms and at longitudinal and transverse joints to prevent honeycombing. Voids in edge of finished pavement will be cause for rejection.

3.07 FINISHING

A Finish concrete pavement with power-driven transverse finishing machines or by hand finishing methods.

1. Use transverse finishing machine to make at least two trips over each area. Make last trip continuous run of not less than 40 feet. After transverse screeding, use hand-operated longitudinal float to test and level surface to required grade.
2. Hand finish with mechanical strike and tamping template as wide as pavement to be finished. Shape template to pavement section. Move strike template forward in direction of placement, maintaining slight excess of material in front of cutting edge. Make at least two trips over each area. Screed pavement surface to required section. Work screed with combined transverse and longitudinal motion in direction work is progressing. Maintain screed in contact with forms. Use longitudinal float to level surface.

B On narrow strips and transitions, finish concrete pavement by hand. Thoroughly work concrete around reinforcement and embedded fixtures. Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge. Tamp concrete with tamping template. Use longitudinal float to level surface.

C While concrete is still workable, give surface final belting to produce a uniform surface of gritty texture. Perform belting with short rapid transverse strokes having sweeping longitudinal motion.

3.08 JOINTS AND JOINT SEALING

A When new work is adjacent to existing concrete, place joints at same location as existing joints in adjacent pavement.

B If the limit of removal of existing concrete or asphaltic pavement does not fall on existing joint, saw cut existing pavement minimum of 1 1/2 inches deep to provide straight, smooth joint surface without chipping, spalling or cracks.

3.09 CONSTRUCTION JOINTS

A Place transverse construction joint wherever concrete placement must be stopped for more than 30 minutes. Place longitudinal construction joints at interior edges of pavement lanes using No. 5 deformed tie bars, 30 inches long and spaced 18 inches on centers.

3.10 EXPANSION JOINTS

A Place 3/4 inch expansion joints at locations shown on Plans. Use no filler shorter than 6 feet. When pavement is 24 feet or narrower, use not more than 2 lengths of filler. Secure pieces to form straight joint. Shape filler accurately to cross section of concrete slab. Use load transmission devices of type and size shown on Plans. Seal with joint sealing compound.

3.11 CONTRACTION JOINTS

A Place contraction joints at same locations as in adjacent pavement or at spaces indicated on Plans. Maximum spacing of contraction/construction joints, 20 feet. Seal groove with joint sealing compound.

3.12 LONGITUDINAL WEAKENED PLANE JOINTS

A Place longitudinal weakened plane joints at spaces indicated on Plans. Seal groove with joint sealing compound.

3.13 SAWED JOINTS

A Contractor may use sawed joints as an alternate to contraction and weakened plane joints. Circular cutter shall be capable of cutting straight line groove minimum of 1/2 inch wide. Depth shall be one quarter of pavement thickness plus 1/2 inch. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, it shall be continued until completed. Make saw cut with one pass. Complete sawing within 24 hours of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.

B Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Provide at least one standby saw in good working order. Maintain an ample supply of saw blades at work site at all times during sawing operations. Sawing equipment shall be on job at all times during concrete placement.

3.14 JOINTS FOR CURB, AND CURB AND GUTTER

A Place 3/4 inch preformed expansion joints through curb and gutters at locations of expansion and contraction joints in pavement; at end of radius returns at street intersections and driveways; and at curb inlets. Maximum spacing shall be 60 foot centers.

3.15 JOINTS FOR CONCRETE DRIVEWAYS

A Provide 3/4 inch expansion joints conforming to ASTM D 1751 across driveway in line with street face of sidewalks, at existing concrete driveways, and along intersections with sidewalks and other structures. Extend expansion joint material full depth of slab. Where dowels are used, wrap or sleeve one end.

3.16 JOINT SEALING

A Seal joints only when surface and joints are dry, ambient temperature is above 50 degrees F but less than 85 degrees F, and weather is not foggy or rainy.

B Joint sealing equipment shall be in first-class working condition, and be approved by the Engineer. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.

C Clean joints of loose scale, dirt, dust and curing compound. Term joint includes wide joint spaces, expansion joints, dummy groove joints or cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.

D Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that, upon completion, surface of sealer within joint will be 1/4 inch below level of adjacent surface or at elevation as directed.

3.17 CONCRETE CURING

A Concrete pavement shall be cured by protecting it against loss of moisture for period of not less than 72 hours immediately upon completion of finishing operations. Do not use membrane curing for concrete pavement to be overlaid by asphaltic concrete.

B Where curing requires use of water, curing shall have prior right to all water supply or supplies. Failure to provide sufficient cover material shall be cause for immediate suspension of concreting operations.

3.18 POLYETHYLENE FILM CURING

A Immediately after finishing surface, and after concrete has taken its initial set, apply water in the form of a fine spray. Cover surface with polyethylene film so film will remain in intimate contact with surface during specified curing period.

B Cover entire surface and both edges of pavement slab. Joints in film sheets shall overlap minimum of 12 inches. Immediately repair tears or holes occurring during curing period by placing acceptable moisture-proof patches or by replacing.

3.19 WATERPROOFED PAPER CURING

A Immediately after finishing surface, and after concrete has taken its initial set, apply water in form of fine spray. Cover surface with waterproofed paper so paper will remain in intimate contact with surface during specified curing period.

B Prepare waterproofed paper to form blankets of sufficient width to cover entire surface and both edges of pavement slab, and not be more than 60 feet in length. Joints in blankets caused by joining paper sheets shall lap not less than 5 inches and shall be securely sealed with asphalt cement having melting point of approximately 180 degrees F. Place blankets to secure an overlap of at least 12 inches. Tears or holes appearing in paper during curing period shall be immediately repaired by cementing patches over defects.

3.20 COTTON MAT CURING

A Immediately after finishing surface, and after concrete has taken its initial set, completely cover surface with cotton mats, thoroughly saturated before application, in such manner that they will contact surface of pavement equally at all points.

B Mats shall remain on pavement for specified curing period. Keep mats saturated so that, when lightly compressed, water will drip freely from them. Keep banked earth or cotton mat covering edges saturated.

3.21 LIQUID MEMBRANE-FORMING COMPOUNDS

A Immediately after finishing surface, and after concrete has taken its initial set, apply liquid membrane-forming compound in accordance with manufacturer's instructions.

3.22 TOLERANCES

A Test entire surface before initial set and correct irregularities or undulations. Bring surface within requirements of following test and then finish. Place 10 foot straightedge parallel to center of roadway to bridge any depressions and touch all high spots. Do not permit ordinates measured from face of straight edge to surface of pavement to exceed 1/16 inch per foot from nearest point of contact. Maximum ordinate with 10 foot straightedge shall not exceed 1/8 inch. Grind spots in excess of requirements of this paragraph to meet surface test requirements. Restore texture by grooving concrete to meet surface finishing specifications.

3.23 FIELD QUALITY CONTROL

A Testing will be performed under provisions of Section 01450 – Testing Laboratory Services.

B Test Specimens: Four test specimen cylinders for compressive strength tests will be made for each 150 cubic yards or less of pavement that is placed in one day. Two specimens will be tested at 7 days. For failed 7-day tests, remaining two specimens will be tested at 28 days. Specimens will be made, cured and tested in accordance with ASTM C 31 and ASTM C 39.

C Yield test will be made in accordance with ASTM C 138 for cement content per cubic yard of concrete. If such cement content is found to be less than that specified per cubic yard, reduce batch weights until amount of cement per cubic yard of concrete conforms to requirements.

D At the Engineer’s direction a minimum of one 4-inch core may be taken at random locations per 1,000 feet per lane or 500 square yards of pavement to measure in-place depth. Each core may be tested for 28 day compressive strength according to methods of ASTM C 42. The 28 day compressive strength of each core tested shall be a minimum of 3000 pounds per square inch.

E Contractor may, at his own expense, request three additional cores in vicinity of cores indicating nonconforming in-place depths. In-place depth at these locations shall be the average of depth of four cores.

F Fill cores and density test sections with new concrete paving or non-shrink grout.

3.24 NONCONFORMING PAVEMENT

A Remove and replace areas of pavement found by cores to be deficient in thickness by more than 10 percent, or that fail compressive strength tests, with new concrete pavement of thickness shown on Plans at no cost to the Owner.

B Areas of concrete pavement found by cores to be deficient in thickness by less than 10 percent shall be remedied at the Owner's direction by one of the following methods:

1. Remove and replace using new concrete pavement of thickness shown on Plans and in accordance with the requirements of this Section at no cost to Owner.
2. Reduce the Unit Price by the ratio of the average thickness (as determined by cores) to the thickness required.

C No adjustments will be made for excess thickness.

3.25 PAVEMENT MARKINGS

A Restore pavement markings to match those existing in accordance with City of Baytown Standard Details and the Engineer's requirements.

3.26 PROTECTION

A Barricade pavement section from use until concrete has attained minimum design strength.

B On those sections of pavement to be opened to traffic, seal joints, clean pavement and place earth against pavement edges before permitting use by traffic. Such opening of pavement to traffic shall not relieve Contractor from his responsibility for Work.

C Maintain concrete paving in good condition until completion of Work.

D Repair defects by replacing concrete to full depth.

END OF SECTION

Section 02762

TEMPORARY AND REMOVABLE REFLECTORIZED PAVEMENT MARKINGS

1.0 GENERAL

1.01 SECTION INCLUDES

A Temporary retroreflective preformed pavement markings.

B Wet retroreflective markers.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 02981 – Blast Cleaning of Pavement

D Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 4061, "Standard Test Methods for Retroreflectance of Horizontal Coatings"
   b. ASTM E 1347, "Standard Test Methods for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry"
   c. ASTM E 303, "Standard Test Methods for Measuring Surface Frictional Properties Using British Pendulum Tester"
   d. ASTM D 1056, "Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubbber"
   e. ASTM E 809, "Standard Practice for Measuring Photometric Characteristics of Retroreflectors"
   f. ASTM E 808, "Standard Practice for Describing Retroreflection"ASTM D 1056, "Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubbber"

1.02 MEASUREMENT AND PAYMENT

A Measurement for temporary pavement markings is on a linear foot basis, for each class, measured and complete in place.

B Payment includes all labor and materials required to complete installation as indicated on Plans.

C Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit manufacturer's product data for each proposed class of marking material and installation instructions for approval. Include certificate by manufacturer that each class of marking conforms to the requirements of this specification.

C Submit details of manufacturer's replacement policy for each class of marker.

1.04 TEMPORARY PAVEMENT MARKING CLASSIFICATIONS

A Class I - Temporary preformed pavement markings suitable for longitudinal and word and symbol markings where removability will be required.

B Class II - Temporary non-removable preformed pavement markings suitable for overlay lane lines, edge lines, and channelizing lines where pavement will be resurfaced.

C Class III - Class I markers with wet reflective markers added every 8 feet.

D Class IV - Class II markers with wet reflective markers added every 8 feet.

1.05 DELIVERY AND STORAGE

A Deliver preformed plastic marking material in rolls or strips.

B Store material in cool dry conditions until application.

2.0 PRODUCTS

2.01 PREFORMED MARKINGS

A Retroreflective preformed markings: White or yellow retroreflective tape on conformable backing with pigments conforming to standard highway colors. Glass beads shall be incorporated in film and a reflective layer of beads shall be bonded to the top surface of the film. Bead adhesion shall be such that beads cannot be easily removed by scratching with a thumbnail.

B Preformed marking shall be precoated with pressure sensitive adhesive and shall have a demonstrated ability to adhere to roadways under climatic and traffic conditions normally encountered in a construction work zone when properly applied.

C Class I markings shall be removable from portland cement and asphaltic concrete pavements intact, or in large pieces, at temperatures above 40 degrees F without use of heat, solvents, grinding, or blast cleaning. Marking film shall be removable after exposure to following minimum traffic exposure when tested on transverse test decks with rolling traffic:

1. Time in Place (days) 632
2. ADT per lane (23% trucks, 3.5 axles/unit) ……..... 9,000
3. Minimum Axle Hits …….. 13,000,000

D Quality performance characteristics:

		CLASS I		CLASS II		TEST METHOD
		WHITE	YELLOW	WHITE	YELLOW	
1.	Init. Retroreflectance (mcd•ft^{-2}•fc^{-1}), min. * @ 86.0º, 0.2º * @ 86.5º, 1.0º	 1770 750	 1310 450	 1360 500	 820 350	ASTM D 4061
2.	Daytime Reflectance Factor "Y" %, min.	65	36	65	36	ASTM E 97
3.	Init. Skid Resistance, Avg. BPN	50		35		ASTM E 303
4.	Refractive Index of Beads, min.	1.9		1.9		Liquid Immersion
5.	Thickness, without adhesive, mils, min.	40		9		Caliper Gauge

* (Entrance Angle, Observation Angle).

2.02 RAISED WET REFLECTIVE MARKERS

A Raised Markers: Expanded rubber extrusions capable of being elastically compressed and deflected when impacted by rotating vehicle tires. Marker body shall have the following properties when tested in accordance with ASTM D 1056:

1. Compression deflection ……. < 16 psi @ 25^0 deflection.
2. Oven aged compression deflection ……..….. % change, +18.
3. Compress set low …… 10%.
4. Water absorption ……..…. < 9%.
5. Density (lbs/ft) ……...……. (-24).

B Markers shall be precoated with pressure sensitive adhesive capable of holding markers to top of preformed marking film.

C Markers shall have enclosed retroreflective lens sheeting elements attached to marker bodies with pressure sensitive adhesive.

1. Retroreflective lenses elements shall have the following initial minimum reflectance when measured in accordance with ASTM E 809:

COLOR	WHITE	YELLOW	WHITE	YELLOW	WHITE	YELLOW	WHITE	YELLOW
Observation Angle	0.2º		0.5º		1.0º		1.5º	
Coeff. of Luminous Intensity, R (cd•fc^{-1})	1.00	0.60	0.40	0.24	0.19	0.11	0.14	0.08

Notes: 1. Test at an entrance angle (Beta 2 horizontal entrance component described in ASTM E 808) of –4º measured from an axis perpendicular to top edge of marker when viewed from above.

2. Angle formed by reflective surface and base of marker shall be between 75º and 90º prior to measurement.

2. Marker reflective elements shall be visible at night, to motorists with low beam headlights, under the following conditions:
   a. Dry conditions ……... 1500 feet
   b. Rainfall at a rate of 1" per hour …… 1000 feet
   c. Rainfall at a rate of 8" per hour ……..... 250 feet

3.0 EXECUTION

3.01 INSTALLATION

A Apply markings to clean dry surfaces in accordance with manufacturer's recommendations at locations indicated on Plans, or as directed by the Engineer.

B Place markings on each paving lift that is to be opened to traffic prior to the end of each day's work.

C Maintain markings, and replace as needed, until they are covered with subsequent paving courses or replaced by permanent markings on final lifts.

3.02 REMOVAL

A Remove and obliterate markings on existing and final lifts used for redirecting traffic during construction. If blast cleaning is required, comply with requirements of Section 02981 – Blast Cleaning of Pavement.

END OF SECTION

Section 02770

CURB, CURB & GUTTER, AND HEADERS

1.0 GENERAL

1.01 SECTION INCLUDES

A Reinforced concrete curb, reinforced monolithic concrete curb and gutter, and mountable curb.

B Paving headers and railroad headers poured monolithically with concrete base or pavement.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 02751 – Concrete Pavement
4. Section 02335 – Subgrade
5. Section 02710 – Base Course for Pavement

1.02 MEASUREMENT AND PAYMENT

A Measurement for curbs and for curbs and gutter is on linear foot basis measured along face of curb.

B Measurement for headers is on linear foot basis measured between lips of gutters adjacent to concrete base and measured between backs of curbs adjacent to concrete pavement.

C No separate payment will be made for curbs poured monolithically with concrete pavement.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit details of proposed formwork for approval.

C Submit proposed mix design and test data for each type and strength of concrete in Work. Include proportions and actual flexural strength obtained from design mixes at required test ages.

D Submit manufacturer's certifications giving properties of reinforcing steel. Provide specimens for testing when required by the Engineer.

2.0 PRODUCTS

2.01 MATERIALS

A Concrete: Conform to material and proportion requirements for concrete of Section 02751 – Concrete Pavement.

B Reinforcing Steel: Conform to material requirements for reinforcing steel of Section 02751 – Concrete Pavement.

C Grout: Nonmetallic, nonshrink grout containing no chloride producing agents conforming to the following requirements.

Compressive strength at 7 days	3,500 psi
Compressive strength at 28 days	8,000 psi
Initial set time	45 minutes
Final set time	1.5 hours

D Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02751 – Concrete Pavement.

E Joint Sealing Compound: Conform to material requirements of Section 02751 – Concrete Pavement.

F Mortar: Mortar finish composed of one part Portland cement and 1½ parts of fine aggregate. Use only when approved by the Engineer.

3.0 EXECUTION

3.01 PREPARATION

A Prepare subgrade or base in accordance with applicable portions of Section 02335 – Subgrade or Section 02710 – Base Course for Pavement.

3.02 PLACEMENT

A Guideline: Set to follow top line of curb. Attach indicator to provide constant comparison between top of curb and guideline. Insure flow lines for monolithic curb and gutters conform to slopes indicated on Plans.

B Forms: Brace sufficiently to maintain position during pour. Use metal templates cut to section shown on Plans.

C Reinforcement: Secure in proper position so that steel will remain in place throughout placement.

D Joints: Place in accordance with Section 02751 – Concrete Pavement. Place dummy groove joints at 6-foot centers at right angles to curb lines. Cut dummy grooves 1/4 inch deep using an approved edging tool.

E Place concrete in forms to required depth. Consolidate thoroughly. Do not permit rock pockets in form. Entirely cover top surfaces with mortar.

3.03 MANUAL FINISHING

A After concrete is in place, remove front curb forms. Form exposed portions of curb, and of curb and gutter, using mule which conforms to curb shape, as shown on Plans.

B Thin coat of mortar may be worked into exposed face of curb using mule and two-handled wooden darby at least 3 feet long.

C Before applying final finish move 10 foot straightedge across gutter and up curb to back form of curb. Repeat until curb and gutter are true to grade and section. Lap straightedge every 5 feet.

D Steel trowel finish surfaces to smooth, even finish. Make face of finished curb true and straight.

E Edge outer edge of gutter with 1/4-inch edger. Finish edges with tool having 1/4 inch radius.

F Finish visible surfaces and edges of finished curb and gutter free from blemishes, form marks and tool marks. Finished curb or curb and gutter shall have uniform color, shape and appearance.

3.04 MECHANICAL FINISHING

A Mechanical curb forming and finishing machines may be used instead of, or in conjunction with, previously described methods, if approved by the Engineer. Use of mechanical methods shall provide specified curb design and finish.

3.05 CURING

A Immediately after finishing operations, cure exposed surfaces of curbs and gutters in accordance with Section 02751 – Concrete Pavement.

3.06 TOLERANCES

A Top surfaces of curb and gutter shall have uniform width and shall be free from humps, sags or other irregularities. Surfaces of curb top, curb face and gutter shall not vary more than 1/8 inch from edge of a 10-foot long straightedge laid along them, except at grade changes.

3.07 PROTECTION OF THE WORK

A Maintain curbs and gutters in good condition until completion of Work.

B Replace damaged curbs and gutters to comply with this Section.

END OF SECTION

Section 02771

CONCRETE SIDEWALKS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Portland Cement Concrete Pavement for Concrete Sidewalks.

B. References to Technical Specifications:

1. Section 01200 - Measurement and Payment Procedures
2. Section 01350 - Submittals
3. Section 01450 - Testing Laboratory Services
4. Section 02751 - Concrete Pavement

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

   a. ASTM C 150, "Standard Specification for Portland Cement"
   b. ASTM C 94, "Standard Specification for Ready-Mixed Concrete"
   c. ASTM C 33, "Standard Specification for Concrete Aggregates"
   d. ASTM A 615, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"
   e. ASTM D 994, "Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)"
   f. ASTM D 1751, "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Type)
   g. ASTM D 6690, "Standard Specification for Joint and Crack Sealants, Hot-Applied, for Concrete and Asphaltic Pavements"
   h. ASTM C 39, "Standard Test Method for Compressive Strength of Concrete"
   i. ASTM C 31, "Standard Practice for Making and Curing Concrete Test Specimens in the Field"
   j. ASTM C 138, "Standard Test Method for Density (Unit Weight),Yield, and Air Content (Gravimetric) of Concrete"
   k. ASTM C 231,"Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method"
   l. ASTM C 42, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete"

2. Texas Accessibility Standards of Architectural Barriers Act, Article 9102, Texas Civil Statues

1.02 MEASUREMENT AND PAYMENT

A. Measurement for concrete sidewalks is on square foot basis.

B. Payment includes all labor and materials required for installation of concrete sidewalks, joints and curing material. No payment will be made for work in areas where sidewalk has been removed for contractor's convenience.

C. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Submittals shall conform to requirements of Section 01350 - Submittals.

2.0 PRODUCTS

2.01 MATERIALS

A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.

B. Reinforcing Steel: conform to material requirements of Section 02751 - Concrete Paving for reinforcing steel. Use No. 4 reinforcing bars.

C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02751 - Concrete Paving.

D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02751 - Concrete Pavement.

E. Forms: Use straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness.

F. Sand Bed: Conform to material requirements for bank run sand.

3.0 EXECUTION

3.01 REPLACEMENT

A. Replace sidewalks which are removed or damaged during construction with thickness and width equivalent to one removed or damaged unless otherwise shown on Drawings. Finish surface (exposed aggregate, brick pavers, etc.) to match existing sidewalk.

B. Provide replaced and new sidewalks with wheelchair ramps when sidewalk intersects curb at street.

3.02 PREPARATION

A. Identify and protect utilities which are to remain.

B. Protect living trees, other plant growth and features designated to remain.

C. Conduct clearing and grubbing operations in accordance with Section 02200 - Site Preparation.

D. Determine sidewalk horizontal and vertical alignment to facilitate drainage and prevent ponding. Location and slopes must be in compliance with Texas Accessibility Academy Standards latest edition and revisions.

E. Excavate subgrade 6 inches beyond outside lines of sidewalk. Shape to line, grade and cross section. Compact 6 inches of select fill to minimum of 95% maximum dry density at optimal or above optimal moisture content as per ASTM D698. For soils with plasticity index above 40 percent, stabilize soil with lime in accordance with Section 02335 - Subgrade. Compact subgrade to minimum of 90 percent maximum dry density at optimum to 3 percent above optimum moisture content, as determined by ASTM D 698. No separate pay for this requirement. This work shall be subsidiary to sidewalk square foot unit pricing.

3.03 PLACEMENT

A. Setting Forms: Straight, unwarped wood or metal forms with nominal depth 1/2" greater than proposed sidewalk thickness. Securely stake forms to line and grade. Maintain position during concrete placement.

B. Reinforcement:

1. Install No. 4 reinforcing bars.

2. Install reinforcing steel as shown on the Drawings. Lay longitudinal bars in walk continuously through expansion joints. Reinforcing bars shall not vary from plan placement by more than 1/4 inch.

3. Use sufficient number of chairs to support reinforcement in manner to maintain reinforcement in center of slab vertically during placement.

4. Drill dowels into existing paving, sidewalk and driveways, secure with epoxy and provide headers as required.

C. Expansion Joints: Install expansion joints with load transfer units in accordance with Section 02751 - Concrete Pavement.

D. Place concrete in forms to specified depth and tamp thoroughly with "jitterbug" tamp, or other acceptable method. Bring mortar to surface.

E. Strike off to smooth finish with wood strike board. Finish smoothly with wood hand float. Brush across sidewalk lightly with fine-haired brush.

F. Apply coating to wheelchair ramp with contrasting color.

G. Unless otherwise indicated on Drawings, mark off sidewalk joints 1/2 inch deep, at spacing equal to width of walk. Use joint tool equal in width to edging tool.

H. Finish edges with tool having 3/8 inch radius.

I. After concrete has set sufficiently, refill space along sides of sidewalk to 1 inch from top of walk with suitable material. Tamp until firm and solid, place sod as applicable. Dispose of excess material. Repair driveways and parking lots damaged by sidewalk excavation in accordance with Section 02980 - Pavement Repair and Resurfacing.

3.04 CURING

A. Conform to requirements of Section 02751 - Concrete Pavement.

3.05 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01450 - Testing Laboratory Services.

B. Compressive Strength Test Specimens: Four test specimens for compressive strength test will be made in accordance with ASTM C 31 for each 30 cubic yards or less of sidewalk that is placed on one day. Two specimens will be tested at 7 days. Remaining two specimens will be tested at 28 days. Specimens will be tested in accordance with ASTM C 39. Minimum compressive strength: 2500 psi at 7 days and 3500 psi at 28 days.

C. Yield test for cement content per cubic yard of concrete will be made in accordance with ASTM C 138. When cement content is found to be less than that specified per cubic yard, reduce batch weights until amount of cement per cubic yard of concrete conforms to requirements.

D. If the Contractor places concrete without notifying the City, Contractor will have the concrete tested by means of core test as specified in ASTM C 42. When concrete does not meet specification, cost of test will be deducted from payment. Contractor will replace the cored section of sidewalk at no cost to City.

E. Sampling of fresh concrete shall be in accordance with ASTM C 172.

F. Take slump tests when cylinders are made and when concrete slump appears excessive.

G. Concrete shall be acceptable when average of two 28 day compression tests is equal to or greater than minimum 28 day strength specified.

H. If either of two tests on field samples is less than average of two tests by more than 10 percent, that entire test shall be considered erratic and not indicative of concrete strength. Core samples will be required of in-place concrete in question.

I. If 28 day laboratory test indicates that concrete of low strength has been placed, test concrete in question by taking cores as directed by Project Manager. Take and test at least three representative cores as specified in ASTM C 42 and deduct cost from payment due.

3.06 NONCONFORMING CONCRETE

A. Remove and replace areas that fail compressive strength tests, with concrete of thickness shown on Drawings.

B. Replace nonconforming sections at no additional cost to City. Replacement section shall be no less in length than the width of sidewalks.

3.07 PROTECTION

A. Maintain newly placed concrete in good condition until completion of Work.

B. Replace damaged areas at no cost to City.

END OF SECTION

Section 02775

CONCRETE DRIVEWAYS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Portland Cement Concrete Pavement for Driveways.

B. References to Technical Specifications:

1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 02751 - Concrete Pavement

C. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. ASTM C 94, "Standard Specification for Ready-Mixed Concrete"
b. ASTM C 33, "Standard Specification for Concrete Aggregates"
c. ASTM C 260
d. ASTM A 615, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"
e. ASTM D 994, "Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)"
f. ASTM D 1751, "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Type)
g. ASTM D 6690, "Standard Specification for Joint and Crack Sealants, Hot-Applied, for Concrete and Asphaltic Pavements"
h. ASTM C 39, "Standard Test Method for Compressive Strength of Concrete"
i. ASTM C 31, "Standard Practice for Making and Curing Concrete Test Specimens in the Field"
j. ASTM C 143, "Standard Test Method for Slump of Hydraulic Cement Concrete"
k. ASTM C 231,"Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method"
l. ASTM C 171, "Standard Specification for Sheet Materials for Curing Concrete"
m. ASTM C 309, "Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete"
n. ASTM C 42, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete"

1.02 MEASUREMENT AND PAYMENT

A. Measurement for concrete driveways is on square yard basis and includes removal of existing driveway, driveway curbs, select fill subgrade and reinforcement dowels.

B. Payment includes all labor and materials required for installation of concrete driveways, joints and curing material. No payment will be made for work in areas where driveway has been removed for contractor's convenience.

C. Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B. Submit proposed mix design and test data for each type and strength of concrete in Work. Include proportions and actual compressive strength obtained from design mixes at required test ages.

C. Submit product data for joint sealing compound and proposed sealing equipment for approval.

D. Submit samples of dowel cup, metal supports, and deformed metal strip for approval.

2.0 PRODUCTS

2.01 MATERIALS

A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.

B. Reinforcing Steel: Conform to material requirements for reinforcing steel of Section 02751 - Concrete Paving. Use No. 4 reinforcing bars.

C. Subgrade Materials: Conform to subgrade material requirements of Section 02335 - Subgrade.

D. Joints: Conform to concrete joint requirements of Section 02751 - Concrete Paving.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade is ready to support imposed loads and meets compaction requirements.

B. Verify lines and grades are correct.

3.02 PREPARATION

A. When removing existing concrete, all sawcuts shall be full depth unless otherwise approved by City.

B. Properly prepare, shape and compact each section of subgrade before placing forms, reinforcing steel or concrete.

C. Excavate subgrade 6 inches beyond outside lines of driveway. Shape to line, grade and cross section. Place compacted select fill as needed to bring grade up. Select fill shall be compacted to minimum of 95% maximum dry density at optimal or above optimal moisture content as per ASTM D698. Stabilize top 8" of subgrade with lime in accordance with Section 02335 - Subgrade. Compact subgrade to minimum of 90 percent maximum dry density at optimum to 3 percent above optimum moisture content, as determined by ASTM D 698. No separate pay for this requirement. This work shall be subsidiary to driveway square yard unit pricing.

3.03 FORMS

A. Side Forms: Use clean forms of approved shape and section. Preferred depth of form shall be equal to required edge thickness of pavement. Forms with depths greater or less than required edge thickness of pavement will be permitted, provided difference between form depth and edge thickness if not greater than 1 inch, and further provided that forms of depth less than pavement edge are brought to required edge thickness by securely attaching wood or metal strips to bottom of form, or by grouting under form. Bottom flange of form shall be same size as thickness of pavement. Aluminum forms are not allowed. All forms shall be approved by the Engineer. Length of form sections shall be not less than 10 feet and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200 foot radius or less. Forms shall have ample strength and shall be provided with adequate devices for secure setting so that when in-place they will withstand, without visible springing or settlement, impact and vibration of finishing machine. In no case shall base width be less than 8 inches for form 8 inches or more in height. Forms shall be free from warp, bends or kinks and shall be sufficiently true to provide reasonable straight edge on concrete. Top of each form section, when tested with straight edge, shall conform to requirements specified for surface of completed pavement. Provide sufficient forms for satisfactory placement of

concrete. For short radius curves, forms less than 10 feet in length or curved forms may be used. For curb returns at street intersections and driveways, wood forms of good grade and quality may be used.

B. Form Setting:

1. Rest forms directly on subgrade. Do not shim with pebbles or dirt. Accurately set forms to required grade and alignment and, during entire operation of placing, compacting and finishing of concrete, do not deviate from this grade and alignment more than 1/8 inch in 10 feet of length. Do not remove forms for at least 8 hours after completion of finishing operations.

3.04 REINFORCING STEEL AND JOINT ASSEMBLIES

A. Accurately place reinforcing steel and joint assemblies and position them securely. Wire reinforcing bars securely together at intersections and splices. Bars and coatings shall be free of rust, dirt or other foreign matter when concrete is placed. Place all reinforcing steel and secure to chairs. All reinforcing steel must be positively supported before pour begins.

B. Place pavement joint assemblies at required locations and elevations, and rigidly secure all parts in required positions. Install dowel bars accurately in joint assemblies as shown, each parallel to pavement surface and to center line of pavement. Rigidly secure in required position to prevent displacement during placing and finishing of concrete. Accurately cut header boards, joint filler and other material used for forming joints to receive each dowel bar. Drill dowels into existing pavement, secure with epoxy, and provide paving headers, as required, to provide rigid pavement sections.

3.05 PLACEMENT

A. Place concrete only in rain-free days when air temperature taken in shade and away from artificial heat is above 35 degrees F and rising. Concrete shall not be placed when temperature is below 40 degrees F and falling.

When concrete temperature is 85 degrees F or above, do not exceed 60 minutes between introduction of cement to the aggregates and discharge. When the weather is such that the concrete temperature would exceed 90 degrees F, employ effective means, such as pre-cooling of aggregates and mixing water, using ice or placing at night, as necessary to maintain concrete temperature, as placed, below 90 degrees F.

B. Place concrete within 60 minutes of mixing. Remove and dispose of concrete not placed within this period.

C. Concrete slump during placement shall be 2 to 4 inches.

D. Deposit concrete rapidly and continuously on subgrade or subbase in successive batches. Distribute concrete to required depth and for entire width of placement in manner that will require as little rehandling as possible. Where hand spreading is necessary, distribute concrete with shovels or by other approved methods. Use only concrete rakes in handling concrete.

E. Take special care in placing and spading concrete against forms and at longitudinal and transverse joints to prevent honeycombing. Voids in edge of finished pavement will be cause for rejection.

3.06 FINISHING

A. Finish concrete driveway with power-driven transverse finishing machines or by hand finishing methods.

1. Use transverse finishing machine to make at least two trips over each area. Make last trip continuous run of not less than 40 feet. After transverse screeding, use hand-operated longitudinal float to test and level surface to required grade.

2. Hand finish with mechanical strike and tamping template as wide as pavement to be finished. Shape template to pavement section. Move strike template forward in direction of placement, maintaining slight excess of material in front of cutting edge. Make at least two trips over each area. Screed pavement surface to required section. Work screed with combined transverse and longitudinal motion in direction work is progressing. Maintain screed in contact with forms. Use longitudinal float to level surface.

B. On narrow strips and transitions, finish concrete driveway by hand. Thoroughly work concrete around reinforcement and embedded fixtures. Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge. Tamp concrete with tamping template. Use longitudinal float to level surface.

C. While concrete is still workable, give surface final belting to produce a uniform surface of gritty texture. Perform belting with short rapid transverse strokes having sweeping longitudinal motion.

3.07 JOINTS AND JOINT SEALING

A. When new work is adjacent to existing concrete, place joints at same location as existing joints in adjacent pavement.

B. Contractor may use sawed joints as an alternate to contraction and weakened plane joints. Circular cutter shall be capable of cutting straight line groove minimum of

1/2 inch wide. Depth shall be one quarter of pavement thickness plus 1/2 inch. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, it shall be continued until completed. Make saw cut with one pass. Complete sawing within 24 hours of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.

C. Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Provide at least one standby saw in good working order. Maintain an ample supply of saw blades at work site at all times during sawing operations. Sawing equipment shall be on job at all times during concrete placement.

D. Provide 3/4 inch expansion joints conforming to ASTM D 1751 across driveway in line with street face of sidewalks, at existing concrete driveways, and along intersections with sidewalks and other structures. Extend expansion joint material full depth of slab. Where dowels are used, wrap or sleeve one end.

E. Seal joints only when surface and joints are dry, ambient temperature is above 50 degrees F but less than 85 degrees F, and weather is not foggy or rainy.

F. Joint sealing equipment shall be in first-class working condition, and be approved by the Engineer. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.

G. Clean joints of loose scale, dirt, dust and curing compound. Term joint includes wide joint spaces, expansion joints, dummy groove joints or cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.

H. Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that, upon completion, surface of sealer within joint will be 1/4 inch below level of adjacent surface or at elevation as directed.

I. Install the first expansion joint at Right-of-Way. The expansion joint shall be spaced at intervals same as the width of driveway. Expansion joint shall be placed at half of the width of the driveway if the width of driveway exceeds 20’.

3.08 CONCRETE CURING

A. Concrete driveway shall be cured by protecting it against loss of moisture for period of not less than 72 hours immediately upon completion of finishing operations. Do not use membrane curing for concrete pavement to be overlaid by asphaltic concrete.

B. Where curing requires use of water, curing shall have prior right to all water supply or supplies. Failure to provide sufficient cover material shall be cause for immediate suspension of concreting operations.

C. Cotton Mat Curing:

1. Immediately after finishing surface, and after concrete has taken its initial set, completely cover surface with cotton mats, thoroughly saturated before application, in such manner that they will contact surface of pavement equally at all points.

2. Mats shall remain on pavement for specified curing period. Keep mats saturated so that, when lightly compressed, water will drip freely from them. Keep banked earth or cotton mat covering edges saturated.

D. Liquid Membrane-Forming Compounds:

1. Immediately after finishing surface, and after concrete has taken its initial set, apply liquid membrane-forming compound in accordance with manufacturer's instructions.

3.09 TOLERANCES

A. Test entire surface before initial set and correct irregularities or undulations. Bring surface within requirements of following test and then finish. Place 10 foot straightedge parallel and longitudinal to center of driveway. Correct any depressions and all high spots.

3.10 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01450 – Testing Laboratory Services and Section 02751 - Concrete Paving.

3.11 PAVEMENT MARKINGS

A. Restore pavement markings to match those existing in accordance with City of Baytown Standard Details and the Engineer's requirements.

3.12 PROTECTION

A. Barricade pavement section from use until concrete has attained minimum design strength.

B. On those sections of driveway to be opened to traffic, seal joints, clean pavement and place earth against pavement edges before permitting use by traffic. Such opening of driveway to traffic shall not relieve Contractor from his responsibility for Work.

C. Maintain concrete paving in good condition until completion of Work.

D. Repair defects by replacing concrete to full depth and limits as directed by Project Manager. Replace nonconforming work at no additional cost to City.

END OF SECTION

Section 02811

LANDSCAPE IRRIGATION

1.0 GENERAL

1.01 SECTION INCLUDES

A Pipe and fittings, valves, sprinkler heads, accessories.

B Control system and wiring for automatic control irrigation system.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 02931 – Landscape and Tree Planting
4. Section 01310 – Coordination and Meetings

D Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM D 2564, "Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for landscape irrigation under this Section. Include cost in Bid Items for which this Work is a component.

B If landscape irrigation is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit manufacturer's data and details for landscape irrigation system to include pressure ratings, rated capacities, and settings of selected models for the following:
1. General-duty valves.
2. Specialty valves.
3. Control-valve boxes.
4. Sprinklers.
5. Irrigation accessories.
6. Controllers.

C Evidence of State of Texas irrigation license and required experience.

D Shop Drawings: Show irrigation system piping, including plan layout, and locations, types, sizes, capacities, and flow characteristics of irrigation system piping components. Include water meters, backflow preventers, valves, piping, sprinklers and accessories, controls, and wiring. Show areas of sprinkler spray and overspray. Show wire size and number of conductors for each control cable.

1.04 DEFINITIONS

A Irrigation Lateral Lines: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

C Irrigation Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

D Architect: The word Architect as used herein shall refer to the Owner's authorized representative or the Landscape Architect or the design engineer.

1.05 RECORD AND AS-BUILT DRAWINGS

A The Contractor shall provide and keep up to date and complete “as-built" record set of drawings which shall be corrected daily and show every change from the original drawings and specifications and the exact "as-built" locations, sizes, and kinds of equipment. This set of drawings shall be kept on the site and shall be used only as a record set.

B These drawings shall also serve as work progress sheets and shall be available at all times for inspection and shall be kept in a location designated by the Architect. Should the record as-built progress sheets not be available for review or not up-to-date at the time of any inspection, it will be assumed no work has been completed and the Contractor will be assessed the cost of that site visit at the current billing rate of the Architect. No other observations shall take place prior to payment of that assessment.

C The Contractor shall make neat and legible notations on the as-built progress sheets daily as the work proceeds, showing the work as actually installed.

D Before the date of the final inspection, the Contractor shall transfer all information from the "as-built" prints to a mylar. Contractor shall use symbols and notation consistent with original drawings.

E The Contractor shall dimension from two (2) permanent points of reference, building comers, sidewalk, or road intersections, etc., the location of the following items:

1. Connection to existing water lines
2. Connection to existing electrical power
3. Gate valves
4. Routing of sprinkler pressure lines (dimensions max. 100’ along routing)

5. Sprinkler control valves
6. Routing of control wiring
7. Quick coupling valves
8. Other related equipment as directed by the Architect
9. Sleeve locations

1.06 EXPLANATION OF DRAWINGS

A Due to the scale of drawings, it is not possible to indicate all offsets, fittings, sleeves, etc., which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc., as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such a manner as to avoid conflicts between irrigation systems, planting, and architectural features.

B All work called for on the drawings by notes or details shall be furnished and installed whether or not specifically mentioned in the specifications.

C The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences should be brought to the attention of the Owner's authorized representative. In the event this notification is not performed, the irrigation contractor shall assume full responsibility for any revisions necessary.

D No irrigation shall be required for undisturbed natural areas or undisturbed existing trees.

1.07 CONTROLLER CHARTS

A As-built drawings shall be approved by the Architect before controller charts are prepared.
1. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturer's representative.
2. Catalog and parts sheets on every material and equipment installed under this contract.
3. Guarantee statement.
4. Complete operating and maintenance instruction on all major equipment.

1.08 UNIFIED DEVELOPMENT CODE (UDC) REFERENCES

A Except for single-family lots and developments, all required landscaping areas shall be 100% irrigated by one of, or a combination of, the following methods:
1. An automatic underground irrigation system:
2. A drip irrigation system;
3. A hose attachment within 100 feet of all plant material, provided, however , that a hose attachment within 200 feet of all plant material in non-street yards shall be sufficient

B Irrigation zone design - A site plan, at a readable and defined scale, shall be submitted illustrating zones, delineating micro-irrigation zones and areas utilizing irrigation techniques other than micro-irrigation. Fifty (50) percent of the on-site green space shall be allowed to utilize irrigation techniques other than micro-irrigation. Turf areas shall be on separate irrigation zones from other landscaping plant zones. The irrigation system should be prepared by a licensed irrigator and designed to accommodate separate landscape plant zones based on different watering requirements unless approved by the Parks Director as indicated in the UDC Section 4.2.2.5, Item 8.D.1.

C Overspray/ Runoff - All irrigation systems shall be designed to avoid overspray / runoff, low head drainage, or other similar conditions where water flows onto or over adjacent property, non-irrigated areas, roadways, walkways, structures, or water features. Narrow areas (four feet wide or less) shall not be irrigated unless micro-irrigation is utilized.

D Landscaping - a site plan shall be submitted identifying all existing vegetation to be preserved, proposed turf, and other landscape areas. Installed trees and plants should be grouped together into landscape plant zones according to water and cultural (soil, climate and light) requirements. Plant groupings based on water requirements are as follows: natural, drought tolerant, and oasis.

E Turf / Turfgrass - A maximum of fifty (50) percent of green space may be planted with turf grass configured with a permanent irrigation system. Turfgrass planted in excess of this limitation shall not have a permanent irrigation system. Micro-irrigation shall not be used on turfgrass unless approved by the Parks Director as indicated in the UDC Section 4.2.2.5, Item 8.D.1.

1.09 SYSTEM DESCRIPTION

A Electric solenoid controlled underground irrigation system.

B Source Power: 120 volt

1.10 QUALITY ASSURANCE

A Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B All irrigation systems shall be designed and sealed in accordance with the Texas Licensed Irrigations Act and shall be professionally installed.

C Installer - Installation of Irrigation System shall be performed under the direction of a State of Texas licensed irrigator with not less than 5 years' experience in this type of work.

D Manufacturer's Directions: Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturers of articles used in this contract furnish directions covering points not shown in the drawings and specifications.

E Ordinances, Codes and Regulations: All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations and requirements of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, these specifications and drawings shall take precedence.

1.11 REGULATORY REQUIREMENTS

A Conform to applicable code for piping and component requirements.

1.12 PRE-INSTALLATION CONFERENCE

A Convene one week prior to commencing work of this Section.

1.13 COORDINATION

A Coordinate work under provisions of Section 01310 – Coordination and Meetings

B Coordinate work under provisions of Section 02931 – Landscape and Tree Planting.

C Coordinate the work with site landscape grading and delivery of plant life.

1.14 PRODUCT DELIVERY AND HANDLING

A Materials shall be delivered in manufacturer's unopened packaging labeled to indicate manufacturer's name and product identification. Ensure that packaging and labeling remain intact until installation. Materials shall be stored protected from the elements, including direct sunlight.

B Pipes shall be handled so as to prevent them from being damaged and to maintain their straightness. Pipe ends shall be wrapped; Pipes shall be stored on beds the full length of the pipes; Damaged or dented pipes or fittings shall not be used.

1.15 SUBSTITUTIONS

A If the Irrigation Contractor wishes to substitute any equipment or materials for those equipment or materials listed on the irrigation drawings and specifications, he may do so by providing the following information to the Owner's authorized representative for approval:

1. Provide a statement indicating the reason for making the substitution. Use a separate sheet of paper for each item to be substituted.
2. Provide descriptive catalog literature, performance charts and flow charts for each item to be substituted.
3. Provide the amount of cost savings if the substituted item is approved.

B Owner's authorized representative shall have the sole responsibility in accepting or rejecting any substituted item as an approved equal to those equipment and materials listed on the irrigation drawings and specifications.

1.16 EXTRA MATERIALS

A Furnish extra components listed as Extra Items in Section 00300 – Bid Proposal.
1. Two sprinkler heads of each type and size.
2. Two valve box keys.
3. Two wrenches for each type head core and for removing and installing each type head.

2.0 PRODUCTS

2.01 MANUFACTURERS

A In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 PIPES, TUBES, AND FITTINGS

A Soft Copper Tube: ASTM B 88, Type L water tube, annealed temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

B Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
1. Copper Pressure Fittings: ASME B 16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought• copper fittings if indicated.
2. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

C Mainline PVC pipe:

1. Pressure Main Line:

a. All main line shall be schedule 40 with solvent welded joints.
b. Pipe shall be made from an NSF approved Type I, Grade I, PVC compound conforming to ASTM resin specification Dl785. All pipe must meet requirements as set forth in Federal Specification PS-22-70, with an appropriate standard dimension (S.D.R.) (Solvent-weld pipe).

2. PVC Non-Pressure Lateral Line Piping:
   a. Non-pressure buried lateral line piping shall be PVC class 200 with solvent-weld joints.
   b. Pipe shall be made from NSF approved, Type I, Grade II PVC com• pound conforming to ASTM resin specification D I 784. All pipes must meet requirements set forth in Federal Specification PS-22-70 with an appropriate standard dimension ratio.
3. Fittings 4" and larger shall be push-on Ductile Iron designed and manufactured using ASTM A-536 Grade 70-50-05 ductile iron with tensile strength of 70,000 psi such as manufactured by Harco or approved equal.
4. Fittings 3" and smaller shall be Schedule 40, I-2, II-I NSF approved conforming to ASTM test procedure D2466 PVC solvent-weld fittings.
5. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of Christie's Red Hot Blue Glue and Primer.
6. All PVC pipe must bear the following markings:
   a. Manufacturer's name.
   b. Nominal pipe size.
   c. Schedule or class.
   d. Pressure rating in P.S.I.
   e. NSF (National Sanitation Foundation) approval.
   f. Date of expiration.
7. All fittings shall bear the manufacturer's name or trademark, material designation, applicable I.P.S., schedule number and NSF seal of approval

D Irrigation Lateral Line pipe
1. Pipes 1/2 inch diameter and larger ASTM D 2231, PVC, 1120 or 1220, SDR 21.0, 200 PSI
2. Pipes 1/4 inch diameter: ASTM D 2241, PVC, 1120 or 1220, SDR 13.5, 315 PSI

E Fittings for Threaded Joints
1. ASTM D 2466, PVC, Schedule 80

F Length of pipes used
1. Use of pipe less than five (5) feet in length is prohibited unless otherwise noted on the plans.

G No use of small scrap material to extend water lines

2.03 GENERAL DUTY VALVES

A Gate valves 4" and smaller shall be MSS SP-80, Class 125, Type 1, nonrising-stem, bronze body with solid wedge, threaded ends, and malleable-iron hand wheel.

B Gate valves 3" and smaller shall be similar to those manufactured by Nibco, Hammond or approved equal

C All gate valves shall be installed per installation detail.

D Install six (6) inches of pee gravel into bottom of all valve boxes.

E Gate valves 6 inch and larger shall be cast or ductile iron. They shall conform to AWWA C-509. Stem shall be fitted with a 2" x2" square wrench nut and shall be opened counter-clockwise. Stem extension shall be added to bring operating nut to within 2 (two) feet of finished grade.

2.04 REMOTE CONTROL VALVES

A Plastic Automatic Control Valves: Molded-plastic body, normally closed, diaphragm type with manual flow adjustment, and operated by 24-V ac solenoid.
1. All electric control valves shall be of the same manufacturer.
2. All electric control valves shall have a manual flow adjustment and pressure regulating module.
3. Provide and install one control valve box for each electric control valve.
4. Electric remote control valve shall be Hunter ICV Series.
5. Install six (6) inches of pea gravel into bottom of all valve boxes.

B Automatic Drain Valves
1. Spring-loaded-ball type of construction and designed to open for drainage if line pressure drops below 2½ to 3 psi.

C Quick-Couplers
1. Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B 1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
    a. Manufacturers:
        i. Hunter
2. All quick couplers shall be installed using "O"-ring style swing joint and located in 10" round valve box with purple lids.

D Remote Control-Valve Boxes
1. Box and cover, with open bottom and openings for piping; designed for installing flush with, grade. Include size as required for valves and service.
2. Valve boxes shall be heavy duty plastic 17 inch by 11-3/4 inch by 12 inch depth, black with black cover.
3. Valve box shall be Series 1419, non-hinged, non-bolt cover, by Carson Industries, Inc., or approved equal.
    a. Manufacturers:
        i. Carson Industries, LLC.
        ii. Christy Concrete Products, Inc.

E Gate Valve and Control Wire Splice Boxes

1. Gate valves and control wire splice boxes shall be heavy duty plastic 10 inch diameter by 10¼ inch deep, black with black cover, No. 910-12B, by Carson Industries, Inc. or approved equal.

F Drainage Backfill

1. Cleaned gravel or crushed stone, graded from 3/8 inch minimum to 1 inch maximum.

2.05 SPRINKLERS

A Brass or plastic housing and corrosion-resistant interior parts designed for uniform coverage over entire spray area indicated, at available water pressure. Manufacturers: Hunter Industries.

B Flush, Surface Sprinklers or VANs (Variable Angle Nozzle): Fixed pattern, with screw-type flow adjustment.

C Bubblers: Fixed pattern, with screw-type flow adjustment.

D Shrubbery Sprinklers: Fixed pattern, with screw-type flow adjustment.

E Pop-up, Spray Sprinklers: Fixed pattern, with screw-type flow adjustment and stainless-steel retraction spring.

F Pop-up, Rotary, Spray Sprinklers: Gear drive, full-circle and adjustable part• circle types.

G Pop-up, Rotary, Impact Sprinklers: Impact drive, full-circle and part-circle types.

H Aboveground, Rotary, Impact Sprinklers: Impact drive, full-circle and part• circle types.

I Matched precipitation rates - Sprays and rotors shall have matching application rates within each irrigation zone.

J MP Rotators: wind resistant multi stream nozzle

2.06 CONTROLLERS

A The ACC controller shall be capable of two-wire decoder control of up to 99 stations via a plug-in decoder output module. The decoder output module shall be field-installable without tools. The decoder output module shall have an intrinsic capability of up to 99 stations, and shall occupy 3 modular expansion slots inside the ACC controller cabinet.

B The decoder output module shall have 6 two-wire output paths to the field. The decoders may be wired in sequence over any combination of the two-wire paths, including all 99 on a single two-wire path. Each path may extend up to 10,000 ft. to the end of the wire run over 14 AWG (l.5mm dia.) wire, or 15,000 ft. over 12 AWG (2mm dia.)

C The wire paths shall be twisted pair; solid-core, color-coded red/blue pairs with each conductor in a polyethylene jacket suitable for direct burial. The two-wire paths shall be Hunter Industries Model IDWIRE I for 14 AWG (1.5mm) conductors, or Model IDWIRE2 for 12 AWG (2mm) conductors for extended range (over 10,000 ft., up to 15,000 ft.).

D All connections in the two-wire paths (outside the controller enclosure) shall be made with 3M DBR-6 waterproof, strain relieving direct burial connectors, or exact equals. Decoder output to solenoid connections shall be made with 3M DBY waterproof, strain-relieving connectors or exact equals. No substitution of wire or wire connection specifications is permissible. All connections, tees, and splices shall be positioned in valve boxes in valve boxes for future location and service.

E One Decoder per valve, installed in the valve box is required unless otherwise approved.

F The installer shall provide adequate earth ground (not to exceed I 0 Ohms) and connect it to one of the decoder ground leads every 750 ft., or every 10th decoder module, whichever is shorter. Also install on each dead end of the wire path.

G The ICD decoders and Sensor Decoders shall be UL and c-UL listed, and shall be CE and C-tick approved.

H Final location of automatic controllers shall be approved by the Owner's authorized representative.

I Unless otherwise noted on the plans, the 120 volt electrical power to the automatic controller location to be furnished by others. The final electric hook-up shall be the responsibility of the Irrigation Contractor.

J If two wire systems are not fitting to the system needed, another Hunter Controller with conventional wiring will be used.

K Controllers will be capable of communicating with offsite Hunter software, unless otherwise approved by owner.

L Control Equipment - Irrigation control equipment shall include and automatic irrigation controller with the following features; program flexibility such as repeat cycles and multiple program capabilities; battery back-up to retain the irrigation programs; and a rain sensor device.

2.07 WIRING

A Wiring: AWG-ULUF 600 volt with solid-copper conductors and insulated cable; suitable for direct burial.

1. Manufacturers:

a. Paige Cable
b. Regency Wire and Cable
c. Approved equal

B Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers and runs over 1,000 LF. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color coded different from feeder• circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.

C Install 3 spare wires from each controller to farthest valve in each direction.

D Where more than one (1) wire is placed in a trench, the wiring shall be taped together at intervals of ten (10) feet.

E An expansion curl shall be provided within three (3) feet of each wire connection. Expansion curl shall be of sufficient length at each splice connection at eachelectric control, so that in case of repair, the valve bonnet may be brought to the surface without disconnecting the control wires.

F Control wires shall be laid loosely in trench without stress or stretching of control wire conductors.

G All splices shall be made with Scotch-Lok #3576 Connector Sealing Packs, DBY (Direct Bury) Splice by 3M or approved equal. Use one splice per connector sealing pack.

H Field splices between the automatic controller and electrical control valves, less than 500' apart, will not be allowed without prior approval of the Architect.

I All field splices shall be installed in a 10" round valve box as specified in section 2.04

2.08 BACKFLOW PREVENTERS

A Backflow Preventers shall be bronze and copper, pressure vacuum breaker assembly Febco No. 765 by Febco Sales, Inc. (CMB Industries), or approved equal. Size as per drawings.
1. Reduced Pressure Backflow: Febco No. 825Y
2. Double Check Assembly: Febco No. 850
3. Or approved equal.

2.09 REMOTE CONTROL VALVE TIES

A Remote control valve ties shall be Christy's Valve I.D. tag model ID-STD-Y with wire to attach numbered tag to valve.

2.10 SOLVENT CEMENT FOR SOLVENT WELDED JOINTS

A CHRISTY'S RED HOT BLUE GLUE T. Christy Enterprises, Inc., or approved equal. Use a compatible primer recommended by the solvent cement manufacturer.

2.11 SEALANT FOR THREADED JOINTS UNDER CONSTANT PRESSURE

A RECTOR SEAL LIQUID TEFLON by Rector Seal Corp., or approved equal.

2.12 SLEEVES UNDER PAVING FOR CONTROL WIRE AND IRRIGATION LINES

A ASTM D 2455, PVC, Schedule 40 sized as shown on drawings.

2.13 FITTINGS FOR THREADED JOINTS

A ASTM D 2466, PVC, Schedule 80

2.14 BACKFLOW ENCLOSURES

A The backflow enclosure shall be of a vandal and weather resistant nature manufactured entirely of formed tubing and rod, coated with a performance polymer alloy coating to prevent injury. The mounting base and locking mechanism shall be manufactured entirely of metal or fiber glass. The locking mechanism shall be of the full release type which allows for complete removal of the enclosure from its mounting base without the use of tools. The handle controlling the locking mechanism shall be concealed within the surface of the enclosure and provide for a padlock.

B The backflow enclosure shall be Strong Box Model manufactured by V.I.T. Products Inc., 800-729-1314. No. SBBC-30CR Or approved equal.

C Hot Box Enclosure – CDR Systems Corporation or approved equal.

2.15 RAINFALL MONITOR

A Provide a Mini-Clik by Hunter Industries or approved equal.

2.16 FLOW SENSOR

A Install Flow sensor- Hunter Flow Click

3.0 EXECUTION

3.01 EXAMINATION

A Site Conditions:
1. Verify location of existing utilities.
2. Verify that required utilities are available, in proper location, and ready for use.
3. All scaled dimensions are approximate.
4. The Contractor shall check and verify all size dimensions and receive Architect's approval prior to proceeding with work under this section.
5. Exercise extreme care in excavating and working near existing utilities.

6. Contractor shall be responsible for damages to utilities which are caused by his operations or neglect. Check existing utilities drawings for existing utility locations.
7. Coordinate installation of sprinkler irrigation materials including pipe, so there shall be No interference with utilities or other construction or difficulty in planting trees, shrubs, and ground covers.
8. Coordinate work with other site contractors.
9. The Contractor shall carefully check all grades to satisfy himself that he may safely proceed before starting work on the sprinkler irrigation system.
10. No machine trenching, unless approved by Architect, is to be done within drip line of trees. Trenching is done by hand, tunneling or boring or other methods shall be approved by Architect.
11. It is understood that the piping layout is diagrammatic and piping shall be routed around trees and shrubs in such manner to avoid damage to plants.

3.02 PREPARATION

A Physical Layout:

1. Piping and head layout is shown on plans in schematic form only.
2. All pipes to be installed directly behind curbs, walks, and walls wherever possible.
3. Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of sprinkler heads.
4. All layouts shall be approved by Architect prior to installation.
5. Route pipes to avoid plants, ground cover and structures.
6. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system.

B Water Supply:

1. Sprinkler Irrigation system shall be connected to water supply points-of-connection as indicated on the drawings.
2. Connections shall be made at approximate locations as shown on drawings. Contractor is responsible for minor changes caused by actual site conditions.
3. Reclaimed systems utilizing purple pipe may be requested by owner. In the event of the installation of a reclaimed system. All components will utilize the same previously described manufacturer to provide ‘purple pipe’ components.
4. All Reclaimed/Purple Pipe systems will conform to 30 TAC §344.1

3.03 TRENCHING

A Refer to Section 02318 – Excavation and Backfill for Utilities for excavating, trenching, and backfilling.

B Location of Heads - Design location is represented as accurately as possible. Make minor adjustments on site with approval of Landscape Architect as necessary to ensure consistent and even spacing where applicable. Set all heads minimum 6" from back of curb and 6" from edge of concrete walls.

C Install piping and wiring in sleeves under sidewalks, roadways, parking lots, and railroads.

D Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3, to 12 inches below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

E Provide minimum cover over top of underground piping according to the following:
1. Irrigation Main Piping: Minimum depth of 18 inches below finished grade.
2. Circuit Piping: 12 inches.
3. Drain Piping: 12 inches.
4. Sleeves: 24 inches.

F Backfill
1. The trenches shall not be backfilled until all required tests are performed, or until cover up is approved by the owner.
2. Trenches shall be carefully back• filled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted in landscaped areas to a dry density equal to adjacent undisturbed soil in planting area.
3. Backfill will conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.
4. A sand material backfill will be initially placed on all lines (minimum 3" depth). No foreign matter larger than one-half (1/2) inch in size will be per• mitted in the initial backfill.
5. Where rock is encountered in trenching, 4" of sand above the pipe and 4" of sand below the pipe will be used as the initial backfill.
6. Flooding of trenches will be permitted only with approval of Architect.
7. If settlement occurs and subsequent adjustments in pipe, valves, sprinkler heads, lawn or planting, or other construction are necessary, the Contractor shall make all required adjustments without cost to the Owner.
8. Trench shall be excavated to accommodate grade changes.
9. Trench shall not be left open overnight unless caution taped or fenced off.
10. Existing Lawns - Where trenching is required across existing lawns, (or in the event of changes or repairs after new lawn has been established), uniformly cut strips of sod 6 inches wider than trench. Remove sod in rolls of suitable size for handling and keep moistened until replanted.
11. Backfill trench to within 6 inches of finished grade and compact.
12. Continue fill with acceptable topsoil and compact to bring sod even with existing lawn.
13. Replant sod within 2 days after removal, roll and water generously; unless new sod or hydro mulch is to be installed.
14. All sod areas not in healthy condition equal to adjoining lawns 30 days after replanting shall be re-sodded and restored to original condition.

3.04 INSTALLATION

A Pipes

1. Piping Mains and Laterals - Lay out sprinkler mainlines and perform line adjustments and site modifications to laterals prior to excavation. Lay pipe on solid sub base, uniformly sloped without humps or depressions.
2. Coordinate pipe installation with conduit installation.
3. PVC pipe Assembly
   a. Cut PVC pipe square and de-burr.
   b. Clean pipe and fittings using primer as recommended by the PVC pipe manufacturer. Use tinted primer to aid in visual inspection and blue glue.
   c. Apply a thin even flow coat of PVC solvent cement to inside of the fitting and pipe mating surface.
   d. Cure joints as recommended by the manufacturer and keep pipe and fitting out of service during curing period.
   e. Construct watertight joints equal or greater in strength than the pipe. Do not tap pipe at fittings.
   f. Install plastic pipe in dry weather, when temperature is above 40 degrees F. and in accordance with manufacturer's written instructions.
   g. Allow joints to cure at least 24 hours at temperature above 40 degrees F before testing.
   h. Plastic pipe shall be snaked in the trenches in a manner to provide for expansion and contraction as recommended by pipe manufacturer.
   i. Extend primer 1/2" beyond glue joint for visual inspection.
   j. Ensure that the pipe is not laid on top of fittings and put under stress in any way prior to cover-up.

B Sleeves under Paving

1. The majority of sleeves under paving exist as shown on drawings. Where boring is required for new sleeves (refer to drawings), it shall be a "wet bore." Install sleeves 12" beyond edge of pavement. Perform trench and backfill in accordance with these specifications.
2. Sleeves shall be marked on the concrete with 1/4" deep "V" cut into curb.

C Concrete Thrust Blocks

1. Install where the rubber-gasketed irrigation main changes direction as at ells and tees and where the rubber-gasketed main terminates.
2. Pressure tests shall not be made for a period of 36 to 48 hours following the completion of pouring of the blocks.
3. Blocks for these mains shall be sized and placed in strict accordance with the pipe manufacturer's specifications and shall be of an adequate size and so placed as to take all thrust created by the maximum internal water pressure.

D Irrigation Heads

1. Flush irrigation lines with full head of water and install heads after hydrostatic test is completed.
2. Install heads at manufacturer's recommended heights.

3. Locate part-circle heads to maintain a minimum distance of 4, 12, 24, 48 inches from walls and inches from other boundaries, unless otherwise indicated.
4. Check for uniformity of coverage and pattern correctness. Adjust for 100% coverage where required.
5. Install nozzles with water running at reduced pressure starting with the head closest to the valve.
6. Adjust arcs and radius at normal operating pressure.
7. Ensure heads do not spray into areas not intended to receive water. Example: streets and sidewalks.
8. Install heads at minimum of six (6) inches from back of curb.
9. Spacing - Sprinkler spacing shall not exceed 55 percent of the sprinkler diameter of coverage.
10. Separate spray and rotors - Sprays and rotors shall not be combined on the same control valve circuit

E Drip Tubing

1. Tubing installed in planting beds is to be placed at spacing indicated on drawings in shallow trench and covered with planting backfill mix l"-2" deep and then covered with mulch.
2. Tubing is to be placed after bed preparation is complete and plant material is planted and root ball anchor is installed.
3. Drip tubing is to be placed on top of root balls of trees in planting beds to allow for even watering of trees.
4. All tubing is to be reviewed by Owner's Representative prior to burying.

F Electric Remote Control Valves

1. Adjust automatic control valves to provide flow rate at rated operating pressure required for each irrigation section.
2. Install valves in valve boxes, arranged for easy adjustment and removal. Locate valves to ensure ease of access for maintenance such that no physical interference with other elements of the project exists.
3. Remote Control Valve Tags to be used in Section 2.09
4. One Remote Control Valve Tag shall be attached to stem of each electric remote control valve. Tags shall be numbered sequentially. Numbers shall correspond to station numbers in electric controller. Provide tags and corresponding numbers for wires pulled for future valves.
5. Valve Boxes - Install valve boxes to cover electric remote control valves. Install one valve per valve box. Top of valve box shall be flush with finished grade. Bury minimum 4 bricks under base of each box as support.
6. Control Wire Splice Boxes - Install control wire splice box to cover any splice in control wire. Top of valve box shall be flush with finished grade. Bury minimum 4 bricks under base of each box as support. Install control wire splice box to cover wires pulled for future valves.

G Gravel Backfill

1. Backfill valve boxes and control wire splice boxes with gravel, minimum 6 inch depth.

H Electric Controller

1. Controllers shall be fully grounded.
2. Connect remote control valves to controller in clockwise sequence to correspond with stations 1, 2, 3, successively.
3. Affix a non-fading copy of irrigation diagram to cabinet door below controller's name. Irrigation diagram shall be sealed between two plastic sheets, 20 mils. Minimum thickness. Irrigation diagram shall show clearly all valves operated by the controller, showing station number, valve size, and type of planting irrigated.
4. Provide lockable cabinet. Provide two keys to Owner. Keys to be matched with existing controller key locking mechanisms.
5. Power to Controller & Locations: Locations shown on plan for controllers is approximate. Final location shall be determined on site by Owner.
6. Contractor shall supply 120 VAC to controller from adjacent existing power sources. Follow local governing codes in electrical work.
7. Lightning Protection and Grounding: Provide full grounding and lightning protection per system manufacturer's recommendations.
8. Wall mounted controllers; electrical meters and breaker boxes shall be mounted on I-beam structures.

I Irrigation Control Wires

1. Provide 24 volt system for control of automatic circuit-section valves of underground irrigation system. Provide unit capacity to suit number of circuits indicated.
2. Install control wires with irrigation mains and laterals in common trench where possible. Lay control wires neatly together to side of pipe. Provide looped slack at valves, comers, bores and snake wire in trench to allow for contraction. Tie wires in bundles at 10 foot intervals. Line splices will be allowed on runs of 500 Ft. or more. Splices shall be made and placed in control wire splice boxes.
3. Provide 12 inch long expansion loop within 3 feet of each wire connection and splice on runs of wire 100 feet or longer.

J Backflow Preventers

1. Make required connection to water supply according to local codes and manufacturer's written instructions.
2. Install pressure type backflow devices at required grade in accordance with the local Plumbing Code.
3. Insulate all above ground piping.

3.05 FIELD QUALITY CONTROL AND TESTING

A General - Notify Landscape Architect 48 hours in advance when testing will be conducted. Conduct tests in presence of Landscape Architect and owner.

B The Parks and Recreation Department will conduct open trench inspections daily, prior to cover-up.

C Hydrostatic Test - Test irrigation main line, before backfilling trenches, to a hydrostatic pressure of not less than 100 psi for 1 hour. Piping may be tested in sections to expedite work. Remove and repair or replace piping and connections which do not pass hydrostatic testing.

D Shut off mainline at backflow preventer during non-working hours until Contractor has demonstrated the mainline is stable.

E Operational Testing - Perform operational testing after hydrostatic testing is completed, backfill is in place and irrigation heads are adjusted to final position.

F Demonstrate to Landscape Architect that system meets coverage requirements, is as specified and indicated, and that automatic controls function properly.

G Coverage requirements are based on operation of one circuit at a time.

H After completion of grading, sodding and rolling of grass areas, carefully adjust lawn sprinkler heads so they will be flush with finish grade. Set shrub sprinkler heads not more than 1/2 inch above top of mulch.

I Ensure watering does not extend into unintended areas, such as roadways and sidewalks.

J Field inspection and testing will be performed.

K Prior to filling, test system for leakage for whole system to maintain 100 psi pressure for one hour.

3.06 FILLING

A Provide 3 inch sand cover over piping. Fill trench and compact to subgrade elevation. Protect piping from displacement.

3.07 ADJUSTING

A Adjust control system to achieve time cycles required.

B Change and adjust head types for full water coverage as directed.

3.08 MAINTENANCE

A Contractor shall correctly maintain the irrigation system during the installation process and throughout the landscaping maintenance service period.

B Contractor shall provide "As Built" Drawings for new work, showing dimensioned location of valves, meters, backflow preventers, controllers, and mainline. Contractor shall request reproducible mylar from the Landscape Architect in preparation of "As Built" Drawings. Contractor shall also provide a small laminated set of plans in each irrigation controller, which is color coded for each set of heads each valve operates.

C Maintenance and management - The landscape and irrigation system shall be maintained and managed to ensure water efficiency, and prevent wasteful practices. This should include, but not limited to: resetting the automatic controller according to the season; flushing the filters; testing the rain sensor device; monitoring, adjusting, and repairing irrigation equipment such that the efficiency of the system is maintained and utilizing turf and landscape best management practices during the maintenance period.

3.09 DEMONSTRATION

A Provide system demonstration.

B Instruct Owner's personnel in operation and maintenance of system, including adjustment of sprinkler heads. Use operation and maintenance material as basis for demonstration.

END OF SECTION

Section 02820

WOOD FENCES AND GATES

1.0 GENERAL

1.01 SECTION INCLUDES

A Fence framework, material components, and accessories.

B Excavation for post bases, concrete foundation for posts, and installation of gates.
1. Manual gates and related hardware.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals

D Referenced Standards:
1. American Society of Testing and Materials (ASTM)
2. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT

A Measurement for fencing shall be on a linear foot basis for type and height noted, measured and complete in place.

B Measurement for gates shall be per each, complete in place.

C Payment includes all labor and materials required to complete installation as indicated on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and specific description of material components.

C Product Data: Provide data on material components including posts, rails, bracing, accessories, fittings, and hardware.

1.04 SYSTEM DESCRIPTION

A Fence height shall be as indicated on Plans or as noted to match height of existing.

B Line post spacing shall not exceed 10 feet, or as shown on Plans.

C Provide bracing as appropriate for structural integrity.

D Concrete posts in the ground at a depth of, at least, ½ the height of the fence.

E The diameter of the post hole shall be, at least, 1 ½ times that of the post, or as shown on Plans.

1.05 QUALIFICATIONS

A Company specializing in installation of the products specified in this Section with minimum three years experience.

1.06 FIELD MEASUREMENTS

A Verify that field measurements are as indicated on Shop Drawings.

2.0 PRODUCTS

A When the Work entails replacement of fence structures, the products shall match or exceed the quality of existing.

3.0 EXECUTION

3.01 INSTALLATION

A Install fence in accordance with the directions of the manufacturer and these Technical Specifications.

B Use a Class B concrete base or better to set posts into the ground. Allow concrete to cure for at least 7 days before attaching remainder of fence.

C Where type of material applies, use standard fence stretching equipment to stretch the fencing before tying it to the rails and posts. Repeat the stretching and tying operations about every 100 feet. Use bottom tension wire where specified on Plans.

D Erect gates so they swing or slide in the appropriate direction. Provide gate stops as required. Secure hardware, adjust, and leave in perfect working order. Adjust hinges and diagonal bracing so that gates will hang level. Adjust rollers and guides of sliding gates so that gates are level.

E Accommodate contour of ground as indicated on Plans.

F Where new fence joins an existing fence, set a corner post and brace post at the junction, or tie in as directed on Plans.

G Nuts and bolts shall be in conformance with ASTM - A307 and shall be galvanized in accordance with AASHTO M232.

H Other hardware indicated on Plans shall be in accordance with ASTM Standards.

END OF SECTION

Section 02821

CHAIN LINK FENCES AND GATES

1.0 GENERAL

1.01 SECTION INCLUDES

A Fence framework, fabric, and accessories.

B Excavation for post bases, concrete foundation for posts and center drop for gates.
1. Manual gates and related hardware.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals

D Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM A 570, "Standard Practice for Roof System Assemblies Employing Steel Deck, Performed Roof Insulation, and Bituminous Built-Up Roofing"
   b. ASTM A 1011, "Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy with Improved Formability"
   c. ASTM A 307, "Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength"
2. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT

A Measurement for fencing shall be on a linear foot basis for height noted, measured and complete in place.

B Measurement for gates shall be per each, complete in place.

C Payment for chain link fences and gates includes all labor and materials required to complete installation as indicated on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.

C Product Data: Provide data on fabric, posts, accessories, fittings and hardware that indicates that items match or exceed the quality of existing.

1.04 SYSTEM DESCRIPTION

A Fence Height shall be as indicated on Plans or as noted to match height of existing.

B Extension arms for barbed wire shall match existing.

C Line Post Spacing shall not exceed 10 feet, or as shown on Plans.

1.05 QUALIFICATIONS

A Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years experience.

1.06 FIELD MEASUREMENTS

A Verify that field measurements are as indicated on Shop Drawings.

2.0 PRODUCTS

2.01 GALVANIZED FENCING

A Fence fabric shall be No. 9 steel wire, hot galvanized after weaving, to match or exceed existing.

B Framework shall be hot-dipped galvanized with a minimum coating of 2 ounces/sf, or one ounce/sf plus 30 micrograms/square inch chromate conversion coating.

C Line posts shall be 2" and conform to ASTM A 570 Grade 45 steel or ASTM A 569, cold rolled steel. All posts shall have spherical plugs.

D End corner, angle, and pull posts shall be 2 1//2" and conform to ASTM A 570 Grade 45 steel or ASTM A 569 for steel pipe.

E Top rails shall be 1.65 x 1.25 inch formed C-section; or 1.6 inch round ASTM A 569, 1.35 lbs/ft; or one 5/8 inch outside diameter steel pipe, 2.27 lbs/ft. Top rails shall pass through openings provided for that purpose in post tops.

F Fabric ties shall be hog rings, galvanized steel wire not less than 9-ga with a zinc coating of not less than 1.2 ounces/sf.

G Bolts and nuts shall be in conformance with ASTM A 307 and shall be galvanized in accordance with AASHTO M232.

H Install horizontal braces fabricated of one 5/8 inch, 2.27lb copper bearing steel pipe at all corner, gate, and end posts.

I All posts to have malleable iron top caps.

J Bottom tension wire shall be #7 gauge wire.

K Gates shall be either swing or slide as shown on the plans. Swing gates shall be hinged to swing 90 degrees from closed to open or hinged to swing 180 degrees from close to open. Slide gates shall be roller type with no vertical obstructions. All gate leaves shall have intermediate members and diagonal stress rods as required for rigid construction and shall be free from sag or twist. All gates shall be fitted with vertical extension arms or shall have frame end number extended to carry barbed wire. Gate posts for gates shall be 4-inch, 9.1 lb pipe. Gate frames shall be made of 2-inch outside diameter, castings. Fabric shall be the same as for the fence. Gates shall have malleable iron ball and socket hinges, catches, stops and padlocks with 3 keys each. Posts for single gates shall be the same as end posts.

3.0 EXECUTION

3.01 INSTALLATION

A Install chain link fence in accordance with the directions of the manufacturer and these Specifications.

B Install line fence posts at not more than 10ft centers and concreted at least 36 inches x 12" diameter into the ground in a Class B concrete base. Allow concrete to cure for at least 7 days before erecting remainder of fence. Fasten fabric to line posts with wire ties spaced about 14 inches apart and to top rail spaced about 24 inches apart.

C Use standard chain link fence stretching equipment to stretch the fabric before tying it to the rails and posts. Repeat the stretching and tying operations about every 100 feet.

D Erect gates so they swing or slide in the appropriate direction. Provide gate stops as required. Secure hardware, adjust, and leave in perfect working order. Adjust hinges and diagonal bracing so that gates will hang level. Adjust rollers and guides of sliding gates so that gates are level.

E At small natural or drainage ditches where it is not practical for the fence to conform to the contour of the ground, span the opening below the fence with wire fastened to stakes of required length. The finished fence shall be plumb, taut, true to line and ground contour. When directed, stake down the chain link fence at several points between posts.

F Where new fence joins an existing fence, set a corner post and brace post at the junction and brace as directed. If the connection is made at other than the corner of the new fence the last span of the old fence shall contain a brace.

END OF SECTION

Section 02910

TOPSOIL

1.0 GENERAL

1.01 SECTION INCLUDES

A Furnishing and placing topsoil for finish grading and for seeding, sodding, and planting.

B References to Technical Specifications:
1. Section 01200 - Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01450 – Testing Laboratory Services
4. Section 01500 – Temporary Facilities and Controls
5. Section 02200 – Site Preparation
6. Section 01140 – Contractor's Use of Premises

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for topsoil under this Section. Include cost in Bid Items for which topsoil is a component.

B If topsoil is included as a Bid Item, measurement will be based on the units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 TESTING

A Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 TOPSOIL

A Topsoil shall be fertile, friable, natural sandy loam surface soil obtained from excavation or borrow operations having the following characteristics:
1. pH value of between 5.5 and 6.5.
2. Liquid limit: topsoil not exceed 50
3. Plasticity index: 10 or less.
4. Gradation: maximum of 40 percent with a passing the #280 sieve.

B Topsoil shall be reasonably free of subsoil, clay lumps, weeds, non-soil materials and other litter or contamination. Topsoil shall not contain roots, stumps, and stones larger than 2 inches.

C Obtain topsoil from the top material from naturally well drained areas where topsoil occurs at a minimum depth of 4 inches and has similar characteristics to that found at the placement site. Do not obtain topsoil from areas infected with a growth of, or reproductive parts of nut grass or other noxious weeds.

3.0 EXECUTION

3.01 EXAMINATION

A Verify that excavation and embankment operations have been completed to correct lines and grades.

3.02 TOPSOIL STRIPPING AND SOTCKPILING

A Conform to topsoil stripping and stockpiling requirements of Section 02200 – Site Preparation.

3.03 PLACEMENT

A Contractor shall conduct erosion control practices described in Section 01566 - Source Controls for Erosion and Sedimentation during topsoil placement operations.

B For areas to be seeded or sodded, scarify or plow existing surface material to a minimum depth of 4 inches, or as indicated on the Plans. Remove any vegetation and foreign inorganic material. Place 4 inches of topsoil on the loosened material and roll lightly with an appropriate lawn roller to consolidate the topsoil.

C Increase depth of topsoil to 6 inches when placed over cement stabilized sand used as bedding and backfill material.

D For areas to receive bushes or trees, excavate existing material and place topsoil to the depth and dimensions shown on the Plans.

E Remove spilled topsoil from curbs, gutters, and, paved areas and dispose of excess topsoil in accordance with requirements of Section 01140 – Contractor's Use of Premises.

3.04 PROTECTION OF THE WORK

A Protect and maintain topsoil until a vegetative cover is established.

B Repair areas damaged by Contractor's operations at no cost to Owner.

END OF SECTION

Section 02921

HYDROMULCH SEEDING

1.0 GENERAL

1.01 SECTION INCLUDES

A Seeding, fertilizing, mulching, and maintaining areas of commercial, industrial, or undeveloped land disturbed during construction and not paved or designated to be paved, or as indicated on Plans.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01500 – Temporary Facilities and Controls
4. Section 02910 – Topsoil
5. Section 02255 – Bedding, Backfill, and Embankment Materials
6. Section 01140 – Contractor's Use of Premises

1.02 MEASUREMEN AND PAYMENT

A Measurement for hydromulch seeding is on a per acre basis, measured and complete in place.

B Payment for hydromulch seeding shall include all labor, materials, equipment, and preparation necessary for application and maintenance.

C No payment shall be made for hydromulch seeding used in restoration of areas disturbed by Contractor outside the limits of construction.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit certification from supplier that each type of seed conforms to these specification requirements and the requirements of the Texas Seed Law. Certification shall accompany seed delivery.

C Submit a certificate stating that fertilizer complies with these specification requirements and the requirements of the Texas Fertilizer Law.

1.04 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 MATERIALS

A Topsoil: Conform to material requirements of Section 02910 – Topsoil.

B Bank Sand: Conform to material requirements of Section 02255 – Bedding, Backfill, and Embankment Materials.

C Seed: Conform to U.S. Department of Agriculture rules and regulations of the Federal Seed Act and the Texas Seed Law. Seed shall be certified 90 percent pure and furnish 80 percent germination and meet the following requirements:

1. Rye: Fresh, clean, Italian rye grass seed (lollium multi-florum), mixed in labeled Proportions. As tested, minimum percentages of impurities and germination must be labeled. Deliver in original unopened containers.
2. Bermuda: Extra-fancy, treated, lawn type common bermuda (Cynodon dactylon). Deliver in original, unopened container showing weight, analysis, name of vender, and germination test results.
3. Wet, moldy, or otherwise damaged seed will not be accepted.

D Fertilizer: Dry and free flowing, inorganic, water soluble commercial fertilizer, which is uniform in composition. Deliver in unopened containers which bear the manufacturers guaranteed analysis. Caked, damaged, or otherwise unsuitable fertilizer will not be accepted. Fertilizer shall contain minimum percentages of the following elements:

Nitrogen:	10 Percent
Phosphoric Acid:	20 Percent
Potash:	10 Percent

E Mulch: Virgin wood cellulose fibers from whole wood chips having a minimum of 20 percent fibers 0.42 inches (10.7 mm) in length and 0.01 inches (0.27 mm) in diameter. Mulch shall be dyed green for coverage verification purposes.

F Soil Stabilizer: "Terra Tack" 1 or approved equal.

G Weed control agent: Pre-emergent herbicide for grass areas, "Benefin" or approved equal.

3.0 EXECUTION

3.01 PREPARATION

A Do not start or perform work under conditions that are not satisfactory to perform tasks due to inclement or impending inclement weather.

B After the areas to receive hydromulch seeding have been brought to grade, rake out any foreign organic or inorganic material, including stones, hard clay lumps, and other debris.

C Level with Bank Sand or Topsoil, as approved by the Engineer.

D Loosen the subgrade by discing or by scarifying to a depth of at least 4 inches.

E Place and compact a layer of topsoil in accordance with requirements of Section 02910 – Topsoil.

F Surface of topsoil shall be smooth and free of weeds, rocks, and other foreign material immediately before applying hydromulch seeding.

3.02 APPLICATION

A Seed: Apply uniformlyat the following rates for type of seed and planting date:

TYPE	APPLICATION RATE POUNDS/A	PLANTING DATE
Hulled Common Bermuda Grass 98/88 Unhulled Common Bermuda Grass 98/88	40 40	Jan 1 to Mar 31
Hulled Common Bermuda Grass 98/88	40	Apr 1 to Sep 30
Hulled Common Bermuda Grass 98/88 Unhulled Common Bermuda Grass 98/88 Annual Rye Grass (Gulf)	40 40 30	Oct 1 to Dec 31

B Fertilizer: Apply uniformly at a rate of 500 pounds per acre.

C Mulch: Apply uniformly at a rate of 50 pounds per 1000 square feet.

D Soil stabilizer: Apply uniformly at a rate of 40 pounds per acre.

E Weed control agent: Apply at manufacturer's recommended rate prior to Hydromulching.

F Suspend all operations under conditions of drought, excessive moisture, high winds, or extreme or prolonged cold. Obtain the Engineer’s approval before resuming operations.

3.03 MAINTENANCE

A Maintain grassed areas by watering, fertilizing, weeding, and trimming as required to establish and sustain 70% acceptable vegetative cover.

B For areas seeded in the fall, continue maintenance the following spring until an acceptable lawn is established.

3.04 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

3.05 PROTECTION OF THE WORK

A Protect and maintain grassed areas a minimum of 90 days, or as required to establish an acceptable lawn.

B Once a lawn is established, protect and maintain it until completion of the Work.

C Replace seeded areas damaged by Contractor's operations at no cost to Owner.

END OF SECTION

Section 02922

SODDING

1.0 GENERAL

1.01 SECTION INCLUDES

A Sodding areas of residential lawns disturbed during construction and not paved or designated to be paved, or as indicated on Plans.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01500 – Temporary Facilities and Controls
4. Section 02910 – Topsoil
5. Section 02255 – Bedding, Backfill, and Embankment Materials
6. Section 01140 – Contractor's Use of Premises

C Definitions:
1. Lawn - ground covered with fine textured grass kept neatly mowed.
2. Sod - blocks, squares, strips of turf grass, and adhering soil used for vegetative planting.

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for Work performed under this Section. Include cost in Bid Items for utility or paving.

B If sodding is included as a Bid Item, measurement will be based on the units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

C No payment shall be made for sodding of restoration areas disturbed by Contractor outside the limits of construction.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit material sources and product quality information in accordance with this Section.

C Submit a certificate stating that fertilizer complies with these specification requirements and the requirements of the Texas Fertilizer Law.

1.04 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 MATERIALS

A Topsoil: Conform to material requirements of Section 02910 – Topsoil.

B Bank Sand: Conform to material requirements of Section 02255 – Bedding, Backfill, and Embankment Materials.

C Fertilizer: Available nutrient percentage by weight: 12 percent nitrogen, 4 percent phosphoric acid, and 8 percent potash; or 15 percent nitrogen, 5 percent phosphoric acid, and 10 percent potash.

D Weed and Insect Treatment: Provide acceptable treatment to protect sod from weed and insect infestation. Submit treatment method to the Engineer for approval. All insect and disease control shall be installed within guidelines set forth by the Structural Pest Control Board of the State of Texas

E Water: Potable, available on-site through Contractor's water trucks. Do not use private resident's water.

2.02 SOD

A Species: Bermuda (Cynodon Dactylon), Buffalo (Buchloe Dactyloides), or St. Augustine to match existing or as directed.

B Contents: 95 percent permanent grass suitable to climate in which it is to be placed; not more than 5 percent weeds and undesirable grasses; good texture, free from obnoxious grasses, roots, stones and foreign materials.

C Size: 12 inch wide strips, uniform in thickness (2 inch minimum with clean-cut edges.

D Sod is to be supplied and maintained in a healthy condition as evidenced by the grass being a normal, green color.

3.0 EXECUTION

3.01 PREPARATION

A Do not start work until conditions are satisfactory. Do not start work during inclement or impending inclement weather. Perform Sodding only when weather and soil conditions are deemed by Engineer to be suitable for proper placement.

B After the areas to receive sod are brought to grade, rake out any foreign organic or inorganic material, including stones, hard clay lumps and other debris.

C Level with Bank Sand or Topsoil, as approved by the Engineer.

D Loosen the subgrade by discing or by scarifying to a depth of at least 4 inches.

E Place and compact topsoil in accordance with requirements of Section 02910 – Topsoil. Top soil shall be free of weeds and foreign material immediately before sodding.

F Spread 2-inch (±1") layer of Bank Sand over prepared topsoil.

G Prior to placing sod, rake areas smooth, free from unsightly variations, bumps, ridges, or depressions, and completely free from stones, hard clay lumps and other debris.

H Apply fertilizer at a rate of 25 lbs/1000 SF. Apply after raking soil surface and not more than 48 hours prior to laying sod. Mix thoroughly into upper 2 inches of soil. Lightly water to aid in dissipation of fertilizer.

3.02 APPLICATION

A Lay sod with closely fitted joints leaving no voids and with ends of sod strips staggered. Sod shall be laid within 24 hours of harvesting.

B After sod is laid, irrigate thoroughly to secure 6-inch minimum penetration into soil below sod.

C Tamp and roll sod with approved equipment to eliminate minor irregularities and to form close contact with soil bed immediately after planting and watering. Submit type of tamping and rolling equipment to be used to the Engineer for approval, prior to construction.

3.03 MAINTENANCE

A Maintenance Period:

1. Begin maintenance immediately after each section of grass sod is installed and continue for a 30-day period from date of Substantial Completion.
2. Re-sod unacceptable areas.
3. Water, fertilize, control disease and insect pests, mow, edge, replace unacceptable materials, and perform other procedures consistent with good horticultural practice to ensure normal, vigorous and healthy growth. All disease control shall be installed within guidelines set forth by the Structural Pest Control Board of the State of Texas.
4. Notify Engineer 10 days before end of maintenance period for inspection.

B Watering:

1. Water lawn areas once a day with minimum 1/2 inch water for the first 3 weeks after area is sodded.

2. After 3-week period, water twice a week with 3/4 inch of water each time unless comparable amount has been provided by rain.
3. Make weekly inspections to determine moisture content of soil unless soil is in frozen condition.
4. Water in the morning to enable soil to absorb maximum amount of water with minimum evaporation.

C Mowing:

1. Mow sod at intervals which will keep grass height from exceeding 3-1/2 inches.
2. Set mower blades at 2-1/2 inches.
3. Do not remove more than one-half of grass leaf surface.
4. Sodded areas requiring mowing within 1 month after installation, shall be mowed with a light-weight rotary type mower. The sod shall be mowed only when dry and not in a saturated or soft condition.
5. Remove grass clippings during or immediately after mowing.

D Fertilizer and Pest Control:

1. Evenly spread fertilizer composite at a rate of 40 pounds per 5,000 square feet or as recommended by manufacturer. Fertilizer shall not be placed until 2 weeks after placement of sod.
2. Restore bare or thin areas by topdressing with a mix of 50 percent sharp sand and 50 percent sphagnum peat moss.
3. Apply mixture 1/4 to 1/2 inch thick.
4. Treat areas of heavy weed and insect infestation as recommended by treatment manufacturer.

3.04 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 - Contractor’s Use of Premises.

3.05 PROTECTION OF THE WORK

A Protect and maintain sod in good condition until 30 days after Substantial Completion.

B Replace sod damaged by Contractor's operations at no cost to Owner.

END OF SECTION

Section 02931

LANDSCAPE AND TREE PLANTING

1.0 GENERAL

1.01 SECTION INCLUDES

A Furnishing all plants and trees, labor, equipment, appliances and materials for landscape and tree planting. Rough and finish grading is part of the landscape work.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 02910 – Topsoil
4. Section 02921 – Hydromulch Seeding
5. Section 01562 – Waste Material Disposal

1.02 MEASUREMENT AND PAYMENT

A Measurement for Landscape Planting is on a Lump Sum.

B Payment for Tree Planting is on lump sum basis for each tree planted.

C Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit samples of the plants and grasses to be used for approval prior to installation. Inspection will be done on the project site.

C Provide materials from the same source and of the same quality and variety as those inspected and approved.

D Soils and/or compost materials must be approved at their source prior to delivery.

1.04 REFERENCES

A ANSI Z 60.1 - Nursery Stock.

B Federal Specification Q-P-166E - Peat, Moss; Peat, Humus; and Peat, Reed-Sedge.

1.05 SCHEDULE

A The plant schedule gives quantities, scientific names, common names, sizes, and special remarks.

B The plant list conforms with *Standardized Plant Names*, 1942, and *American Standard for Nursery Stock*, 1949, revised April 14, 2014, as prepared by the American Joint Committee on Horticultural Nomenclature and the American Association of Nurserymen, Inc.

C In case of discrepancies between the plant list and drawings, the working drawings shall govern.

1.06 DELIVERY AND STORAGE OF MATERIALS

A Pack all plant material to provide protection against damage from wind, weather or other possible sources. Tie plants to prevent whipping when shipment is made by truck.

B When shipment is made by rail, pack plants and ventilate cars as required to prevent sweating.

C Provide a platform from all B&B root balls over 24 inches in diameter.

D Store plants on the site as directed.

E Spray with anti-transpirant at time of delivery in warm season months. Apply at rates in accordance with manufacturer's recommendations.

F Ship trees with Certificates of Inspection as required by governing authorities. Label each tree and shrub with securely attached waterproof tag bearing legible designation of botanical and common name. Do not remove container grown stock from containers before time of planting.

G Deliver packaged materials in fully labeled original containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at Site.

H Materials shall not be pruned prior to installation unless approved by the Engineer in writing. Do not bend or bind-tie trees or shrubs in such a manner as to damage bark, break branches, or destroy natural shape. Use protective covering during delivery.

1.07 SUBSTITUTIONS

A Substitution of larger size or better grade than specified will be allowed, but with no increase in unit cost.

B Substitution of an alternate species may be accepted upon written approval from the Engineer.

1.08 ACCEPTANCE AND APPROVAL

A There will be no partial acceptance of grasses.

B Upon Contractor's request, final approval will be made within 15 working days of date of notice to the Engineer if contracted work has been satisfactorily completed.

C Final approval of grasses will be given when the following conditions are met:
1. There are no bare spots larger than 9 inches square.
2. The total area of bare spots does not exceed 5 percent of the entire grass area.

1.09 WARRANTY

A Provide 1-year warranty on all plants and grasses. The warranty period commences after final completion.

B Replace plants that fail during the warranty period according to the specifications governing the original plants.

C Periodically inspect plants for proper watering and spraying, during warranty period.

D Damage caused by natural hazards such as hail, high winds or storm is not covered by the warranty.

E Plant materials and grasses which die due to normal insects or diseases are included in the warranty.

F Existing in situ plant material required to be moved on the site will be protected under the warranty.

G Contractor shall warrant trees against defects including death, unsatisfactory growth, or loss of shape due to improper pruning, maintenance, or weather conditions, for 1 year after completion of planting. Contractor shall plumb leaning trees during warranty period.

H Remove and replace trees found to be dead during warranty period. Remove and replace trees which are in doubtful condition at end of warranty period, or if approved by the Engineer, extend warranty period for such trees for a full growing season.

1.10 SOIL ANALYSIS

A Submit for approval an analysis of all soils obtained from off-site sources prior to delivery.

B Analysis of existing soil is not required.

1.11 PLANT CERTIFICATES

A Submit inspection certificates approved by the Engineer as required by law with the invoice for each shipment or order of stock:
1. Submit certificates to the Engineer for review in ample time to be reviewed and meet installation schedule.

1.12 PROTECTION OF PERSONS AND PROPERTY

A Take all reasonable precautions to prevent injury to people and to avoid damage to existing structures, plants and grasses. Keep the area free of hazardous obstructions.

B Construct barricades where necessary for the protection of persons and property. Mark all barricades with red and white paint and with red reflectors. Erect barricades in the following locations:

1. Areas dangerous to workmen and passersby.
2. Along adjoining property that requires protection.
3. Across streets and walks that are temporarily closed or rerouted.
4. Around plants and trees to be protected.

C Excavations larger than 1 foot deep and 1 foot wide must be covered when not attended.

D Existing trees which may be subject to damage must be protected by fencing or boxing.

E During the course of planting operations, protect all installed plants and lawns from damage. If heavy equipment or materials must be moved across lawns, use planks or pontoons to protect the turf. Similarly protect walks across which heavy equipment must pass.

1.13 DEFINITIONS

A In situ refers to any soil which is existing and in place on the project site at the time landscape work commences.

B Establishment period refers to a period of 45 days after installation during which time 5 percent of the construction costs will be withheld.

1.14 QUALITY ASSURANCE

A Landscaper shall be a firm specializing in landscape and planting work.

B Do not make substitutions of approved trees unless approved in writing by the Engineer. If specified planting material is not obtainable, submit proof of non-availability together with proposal for use of equivalent material. Substitutions of larger size or better grade than specified will be allowed, but with no increase in unit price.

2.0 PRODUCTS

2.01 TOPSOIL

A Topsoil: Conform to requirements of Section 02910 - Topsoil.

B Peat moss, bark, and fertilizer: Use material recommended by nursery for establishment of healthy stock after replanting. Moss shall conform to requirements of Federal Specification Q-P-166E.

2.02 FERTILIZER

A Provide an inorganic commercial fertilizer which is uniform in composition, dry and free flowing, in original unopened containers, each bearing the manufacturer's guaranteed analysis. Caked, damaged or otherwise unsuitable fertilizer will not be accepted.

1. For lawns: 12-24-12.
2. For ground cover areas, shrub beds and tree holes: 20-10-5 (Except for Genus *Pyrus* (Pear).

2.03 ADDITIVES

A Adjustment of pH. For topsoil to attain the specified pH level, furnish raw, ground agricultural limestone containing not less than 85 percent calcium carbonate of which 50 percent will pass through a 100-mesh sieve and 90 percent through a 70-mesh sieve. Wait 2 months after planting before application of fertilizer.

1. following table is a guideline to establish the pounds of limestone needed per 1000 square feet of turf:

LIMESTONE NEEDED PER 1000 SQUARE FEET			
SOIL PH	**SANDS, LOAMY SANDS**	**SANDY LOAM**	**CLAY LOAM, CLAY**
>6.0	0	0	0
5.1 - 6.0	50	75	100
<5.0	100	125	175

B Humus. Provide a rich humus material free of sticks, stones, weedy roots, or other foreign matter. Humus must have ample water holding capacity and plant food retention. Use a humus with a dark brown to black color.

C Dressing Mulch. Provide pine or redwood bark that is evenly shredded, consisting of 90 percent organic matter, brown in color, and free of harmful minerals. Maximum particle size not to exceed 3 inches in diameter.

D Sharp Sand. Obtain clean sharp sand of hard durable grains, free from dirt, organic matter or other impurities. Use sand with a grade between 0.05 mm and 2 mm.

E Concrete Gravel. Provide clean, crushed stone consisting of hard, durable, uncoated particles free from injurious amounts of soft friable, thin or laminated pieces. Use gravel which conforms to ASTM C 33. The sieve size will be 3/4 inch, 90 to 100 percent passing.

2.04 CONSTRUCTION MATERIALS

A Root Ball Anchors:

1. Duck bills will be used to secure the root ball anchors.

B Edging:

1. Provide 1/2-inch x 4 inches, Cypress or Treated Lumber headerboard.
2. Provide 1 inch x 2 inches x 12 inches, Cypress or Treated Lumber stakes.

C Cloth for Balling Trees. Use burlap of jute weighing at least 7.2 ounces per square yard. Secure balled plants with 2-ply twine made of jute.

D Paper for Wrapping Trees. Use first quality, 4-inch-wide bituminous impregnated tape, corrugated or crepe paper, specifically manufactured for tree wrapping and having qualities to resist insect infestation.

E Materials for Flagging Trees:
1. Mark guyed trees with surveyors white plastic tape.
2. Use surveyors plastic tape for marking as follows.
   a. Red to be removed.
   b. Yellow to be transplanted.
   c. Green to remain.
   d. Blue to identify special handling.

F Labels. Legibly label plants with durable labels that identify the plant by scientific and common name. Use waterproof ink.

G Tree Seal. All pruning cuts, bruises, or scars over 3/4 inch in diameter on trees will be treated with a commercial tree wound dressing.

H Polyethylene. Use virgin base, resin blended polyethylene sheeting with carbon black concentrate of 2.5 percent.

2.05 SPRAYS

A Sterilization:
1. Use approved solution of Dyclomec 4G, or equal, for areas to be planted.
2. Use Pramitol, or equal, for areas to be paved.

B Herbicides:
1. Use an approved systemic non-selective, post emergent herbicide on specified areas to kill all vegetation.
2. Use Confront, or equal, for general control of broadleaf weeds in lawns.
3. Use Preemerg, Eptam, Dryclomec, or equal for ground cover.
4. Use an approved pre-emergent to control seed germination in specified areas.

C Antitranspirant:
1. Use approved antitranspirant for all plant material that is stored and/or heeled-in on the site.
2. Use approved antitranspirant on all planted trees and shrubs.

D Root Stimulant. Use approved root stimulant on all newly planted trees, shrubs, vines and/or ground cover areas.

2.06 PLANT CHARACTERISTICS

A Provide plants which are true to type and name, and typical of their species or variety. Plants must have a normal, well-developed branch structure, with a vigorous root system, and must be generally sound and healthy. Use plants which are free from defects, including:

1. Disfiguring knots.
2. Sun scald.
3. Injuries.
4. Bark abrasions.
5. Plant diseases.
6. Insect eggs.
7. Borers.
8. Infestations.

B Select well-formed plants balanced between height and spread typical of the species or variety with branches in normal position. Heading back plants to meet size limits will not be permitted.

C Unless otherwise specified, all plants will be nursery grown and at least twice transplanted. Use plants which have been growing under similar climatic conditions to those of the project for at least 2 years prior to the date of the contract. Recently stepped-up plants will not be acceptable. All B&B or bare root plants must be freshly dug; heeled-in or cold storage plants will not be accepted.

D Balled, bare root, and container-grown plants will conform to the definitions given in *American Standards for Nursery Stock*.

E No tree will be accepted which has had leaders cut or damaged, or which has a thin, weak trunk and/or poorly formed tops.

F Regardless of sample selection, a plant may be rejected at the site by the Engineer.

2.07 NURSERY STOCK

A Deciduous Trees. Provide trees which are straight and symmetrical and have a persistently preferred main leader. The crown must be in good overall proportion to the entire height of the tree. Where a clump is specified, a plant having a minimum of three stems originating from a common base at the ground line will be furnish. Measure trees by average caliper of trunk.

1. For trees up to 4 inches in diameter, measure caliper 6 inches above ground.
2. For trunks larger than 4 inches, measure caliper 12 inches above ground.

B Evergreen Trees. Form of the top will be typical of the species and not unnaturally sheared or color-treated. Measure by average caliper. Caliper will be taken 6 inches above the ground on trees up to 4 inches in diameter and 12 inches above the ground on trees larger than 4 inches.

C Vines and Ground Cover. Provide plants which are container-grown for sufficient time to ensure adequate root growth to hold the soil in place and retain the original shape when removed from the container.

2.08 FIELD-COLLECTED PLANTS

A Field-collected plants must be grown in favorable locations that ensure fibrous roots and vigorous growth. Such plants will be selected on site by the Landscape architect.

B Provide balls at least 1/3 greater in diameter than those specified for nursery stock.

C If dug in dormant season and bare root is acceptable, the spread of roots must be at least 1/3 greater than the spread of roots for bare root nursery stock.

2.09 SEED

A Seasonal Limitations:
1. Bermuda:
   a. Hulled seeds may be planted between October and March.
   b. Unhulled seeds may be planted between April and September.
2. Rye:
   a. Plant between October and February.

B Bermuda. Provide common Bermuda seed that is extra-fancy, treated, lawn type. Deliver in original, unopened container showing weight, analysis, name of vendor and germination test results. Wet, moldy, or otherwise damaged seed will not be accepted.

C Rye. Deliver annual Winter Rye seed in original unopened containers. Seed must be fresh, clean, and mixed in labeled proportions. As tested, minimum percentages of impurities and germination must be labeled.

2.10 HYDROMULCH

A Provide hydromulch seeding as noted in Section 02921 – Hydromulch Seeding.

2.11 GRASS

A Obtain certified sod from an approved source.

B Provide material which is true to type and name, and is typical of the species or variety.

C Delivery:
1. Identify and tag sods with correct scientific and common name for each species.
2. Do not deliver more sods than can be planted within 8 hours.
3. Transport and deliver sods in/on pallets.
4. Protect sods against dehydration, overheating or contamination during transportation and delivery.

5. Cover unplanted sods with moistened burlap to prevent dehydration or overheating while awaiting installation.
6. Sods must be harvested within 12 hours of planting and arrive at the project site in a moist condition.

D Products:

1. Material to be uniform in color, leaf texture and density.
2. Material to be graded No. 1, or better.
3. Uniform mowed height at time of harvesting material: 1-1/2 inches.
4. Inspected and certified free of diseases, nematodes, and undesirable insects by authorized representative of State Department of Agriculture.
5. Material will not be acceptable if it contains any quack grass, Johnson grass, poison ivy, nut grass, thistle, common bent grass, wild garlic, morning glory, perennial sorrell, or brome grass.
6. Turf will be considered weed free when found to contain less than 1 percent of dandelion, jimson weed, mustard, chickweed, per 100 square feet.

2.12 TREES

A Provide container grown trees which are straight and symmetrical and have a persistently preferred main leader. The crown shall be in good overall proportion to the entire height of tree with branching configuration as recommended by ANSI Z60.1 for type and species specified. Where a clump is specified, a plant having a minimum of three stems originating from a common base at the ground line shall be furnished. Measure trees by average caliper of trunk as follows:

1. For trunks up to 4 inches or less in diameter, measure caliper 6 inches above top of root ball.
2. For trunks more than 4 inches, measure caliper 12 inches above top of root ball.
3. Caliper measurements shall be by diameter tape measure. Indicated calipers on plans are minimum. Averaging of plant calibers will not be allowed.

B Trees shall conform to following requirements:

1. Healthy, vigorous stock, grown in a recognized nursery.
2. Free of disease, insects, eggs, larvae; and free of defects such as knots, sun-scald, injuries, abrasions, disfigurement, or borers and infestations.

2.13 WATER

A Water shall be potable from municipal water supplies.

2.14 SOURCE QUALITY CONTROL

A Notify Engineer, prior to installation, of location where trees that have been selected for planting may be inspected. Plant material will be inspected for compliance with following requirements.

1. Genus, species, variety, size and quality.
2. Size and condition of balls and root systems, insects, injuries and latent defects.

2.15 WORK CONDITIONS

A Site Availability. Begin no landscape work where conflicting site work is incomplete or as otherwise directed by the Engineer.

B Weather Restrictions. Stop all work during inclement weather such as drought, high winds, excessive rain, extreme heat, cold, or freeze. Obtain authorization before resuming work.

2.16 PLANTING PROCEDURES

A Temporary Nursery. A temporary nursery may be used to store plants, but no more than 5 days before planting. Keep plants well watered and protected.

1. Immediately upon delivery, heel-in balled and burlapped (B&B) plants and spray all plants with an antitranspirant. Apply spray from top to bottom. Thoroughly cover plants, but not to the point of run-off. Spray block units and not individual plants. Use a low-pressure, fine-mist applicator. Spray at rates recommended in the manufacturer's directions.
2. Handle all balled and burlapped plants by the ball only.
3. Upon delivery, immediately heel-in bare root plants. Open bundles, separate plants, set roots in trenches, and cover with topsoil. Water plants with an approved root stimulant containing vitamin B.
4. Handle container plants by the container.
5. Handle ground cover plants in flats. Pack flats tightly together and sprinkle plants every day.
6. Special plants so designated must be kept in an approved enclosure or planted the day of delivery.
7. Store soils and additives on approved platforms.

B Digging and Handling:

1. The actual planting operation must proceed without delay and in a manner to avoid undue drying of the in-situ soil or roots because of exposure to air and sun. Keep ample supplies of sawdust available to cover the roots of B&B stocks arriving from the storage nurseries. Keep the roots well covered and moist until the plants can be placed in the final location and permanently planted.
2. Handle all plant stock with care to prevent injuries to the trunk, branches and roots.
3. Dig bare root plants when fully dormant. Keep all of the root system intact; do not prune the root system. However, any roots that are broken, crushed, or bruised must be cleanly cut back to sound wood. Make the cut on an angle so that the exposed end faces downward. Seal any cut root exceeding 3/4 inch in diameter with an approved tree wound dressing.
4. Balled and burlapped plants must have the root system encased in a firm, solid ball of natural earth, wrapped in burlap and tightly bound. Each ball must be of sufficient size to encompass all the fibrous feeding roots and not smaller than required by *American Standards for Nursery Stock*. The ball must remain firm and compact throughout the planting operations.

3.0 EXECUTION

3.01 SITE PREPARATION

A Schedule work so that planting can proceed rapidly as portions of site become available. Plant trees after final grades are established and prior to planting of lawns, unless otherwise approved by Engineer in writing. If planting of trees occurs after seeding work, protect lawn areas and promptly repair damage to lawns resulting from tree planting operations.

B Layout individual trees at locations shown on Drawings. In case of conflicts, notify Engineer before proceeding with Work. Trees shall be staked and approved by Engineer prior to planting.

C Existing Trees:

1. Protection: Protect tops, trunks and roots of trees to remain on the site. Before starting work, box, fence or otherwise protect trees subject to construction damage. Remove boxing when directed. Permit no stockpiles of heavy equipment within the branch spread of trees.
2. Removal: Remove trees marked for removal. Do not remove any tree without proper authorization. Stumps within 36 inches of final grade must also be removed.
3. Pruning and Surgery: Cut and trim trees only as directed; do not cut any tree without proper authorization. Trim existing trees of dead or diseased limbs. Cut limbs close to the trunk. Cover cuts over 3/4 inch in diameter with an approved tree would dressing.

D Grading Around Trees. As required, fill or grade within the branch spread of trees to remain, observing the following requirements.

1. For trenching beneath trees, tunnel under the tree roots with careful hand digging. Where possible, avoid cutting or injuring roots.
2. Do not raise or lower the grade around an existing tree in any way unless so directed.

E Placing Topsoil:

1. Disk, drag, harrow, or handrake subgrade. Scarify the subgrade to a depth of 1-1/2 inches. Before placing topsoil, rake the subsoil surface clear of stones, wood, rubbish and other debris. Place no topsoil until the subgrade preparation has been approved.
2. Spread, rake, and compact topsoil to form a layer with a minimum depth of 4 inches in lawn areas and 6 inches in shrub areas. Place topsoil to conform to finished gradients as shown on the grading plan.
3. Remove spilled topsoil from curbs, gutters, and, paved areas and dispose of excess topsoil in accordance with requirements of Section 01562 – Waste Material Disposal.

F In Situ Soil Preparation:

1. Cross-till in two directions all existing soil in designated areas to be planted, as follows:
   a. In lawn areas to a minimum depth of 6 inches.
   b. In shrub areas to a minimum depth of 10 inches.
2. Evenly broadcast fertilizers and soil additives and thoroughly work into soil.
   a. Smooth all tilled and amended areas to establish a rough gradient.
   b. Deeply irrigate all tilled and amended areas to thoroughly wet soil particles and promote settlement.
   c. After a settlement period of not less than 5 days, and before proceeding with any planting, smooth and rake as necessary to establish finish gradient as required.
3. In all areas which have been utilized for parking, storage or construction lots and/or where heavy equipment has been used, cross-rip the entire compacted areas in two directions to a depth of 10 inches before tilling and amending the soil as specified. A heavy float or drag harrow should be used to smooth all surface areas.
   a. Verify location of all underground utilities before ripping.
   b. Ripping teeth should not be set at more than 10-inch spacing.

G Fertilizer. Evenly broadcast and work fertilizer into soil at the following rates:

1. Lawns: 1-1/2 N pounds per 1000 square feet.
2. Ground Cover, Shrub, and Tree Areas: 1-1/2 N pounds per 1000 square feet.

H Additives:

1. Humus. Evenly broadcast and work into in situ soil at a rate of 1 cubic yard per 200 square feet.
2. Sharp Sand. Evenly broadcast and work into in situ soil at a rate of 1 cubic yard per 200 square feet.
3. Concrete Gravel. Utilize as a drainage course as shown on construction drawings.

3.02 PREPARATION OF PLANTING SOIL

A Before mixing, clean topsoil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.

B Strip and utilize 4-inch layer of top soil, placed on esplanades under Section 02921 – Hydromulch Seeding, for planting soil mixture.

C Mix recommended soil amendments with topsoil at following rates:

1. Top soil: 50 percent.
2. Peat moss: 25 percent.
3. Well rotted Bark: 25 percent.
4. Fertilizer: Rate recommended by nursery.

D Delay mixing of fertilizer if planting will not follow placing of planting soil within 48 hours, unless otherwise directed.

E Incorporate amendments into the soil as a part of the soil preparation process prior to fine grading, fertilizing, and planting. Broadcast or spread amendments evenly at the specified rate over the planting area. Thoroughly incorporate amendments into the top 3 or 4 inches of soil until amendments are pulverized and have become a homogeneous layer of topsoil ready for planting.

3.03 PLANTING

A Excavate pits, beds, or trenches with vertical sides and with bottom of excavation raised a minimum of 6 inches at center for proper drainage. Provide following minimum widths:

1. 15-gallon containers or larger, 2 feet wider than diameter of root ball.
2. 1- and 5-gallon containers, 6 inches wider than diameter of root ball.

B When conditions detrimental to plant growth are encountered, such as unsatisfactory soil, obstructions, or adverse drainage conditions, notify the Engineer of such conditions before planting.

C Deliver trees after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after deliver, set trees and shrubs in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap, or other acceptable means of retaining moisture, and water as needed.

D Set root ball on undisturbed soil in center of pit or trench and plumb plant. Place plants at such a level that, after settlement, a natural relationship of plant crown with ground surface will be established.

E When set, place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

F Dish top of backfill to allow for mulching. Mulch pits, trenches and planted areas. Provide no more than 4-inch thickness of mulch, work into top of backfill, and finish level with adjacent finish grades. Cover entire root ball.

G Prune, thin out and shape trees in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed in writing, do not cut tree leaders, and remove only injured and dead branches from flowering trees. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

H Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures.

I Anchor root ball immediately after planting.

J Control dust caused by planting operations. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

3.04 PLANTING GRASS

A Preparation: Prepare imported topsoil and/or in situ soil. Hand rake to remove all sticks, stones and clods larger than 1 inch. Apply the final grade but do not mechanically compact the soil.

B Seed:

1. Evenly broadcast seed specified in 2.09 at the following rates:
   a. Bermuda: 1 pound per 1000 square feet
   b. Rye: 6 pounds per 1,000 square feet
2. Roll the entire seeded area in two directions with a dry/weighted roller.
3. Evenly top dress the entire seeded area with an approved sterilized commercial steer manure. Apply at 2 cubic feet per 100 square feet.
4. Lightly but thoroughly sprinkle the entire seeded area with water after top dress application.

C Sod:

1. Use Bermuda, Buffalo, or St. Augustine sod in accordance with 2.11A.
2. Prepare soil in accordance with 3.03.
3. Apply eptam (or approved equal) to all areas to be sodded. Follow manufacturers recommended rates and apply during soil preparation period.
4. Lay sod in a running bond pattern. Pieces should be consistently cut with joints tightly butted together. Water the in-place sod liberally and roll it in two direction with a heavy roller. Areas not level due to fluctuations in the sod depth should be covered and leveled with a 50/50 mix of sharp sand and topsoil. Fertilize in 6 weeks as directed by landscape Architect.

3.05 FIELD QUALITY CONTROL

A The Engineer may reject unsatisfactory or defective material at anytime during progress of Work. Contractor shall remove rejected trees immediately from site and replace with specified materials. Plant material not installed in accordance with these Specifications will be rejected.

B An inspection to determine final acceptance will be conducted by the Engineer at the end of the 12 month maintenance period. Additional inspections will be conducted for extended warranty periods provided for in paragraph 1.07B.

3.06 CLEANING AND MAINTENANCE

A Contractor shall maintain trees during planting operations and for a period of 12 months after completion of planting.

B Water trees to full depth a minimum of once each week, or as required to maintain a healthy vigorous growth.

C Prune, cultivate, and weed as required for healthy growth. Restore planting saucers. Tighten and repair rootball anchors, and reset trees and shrubs to proper grades or vertical position as required. Restore or replace damaged wrappings. Spray as required to keep trees and shrubs free of insects and disease.

3.07 PROTECTION OF THE WORK

A During planting work, keep pavements clean and work area in an orderly condition.

B Protect planting work and materials from damage due to planting operations. Maintain protection during installation and maintenance period. Treat, repair, or replace damaged planting work as directed by the Engineer.

C Dispose of excess soil and waste in accordance with requirements of Section 01562 – Waste Material Disposal. On-site burning of combustible cleared materials will not be permitted.

END OF SECTION

Section 02980

PAVEMENT REPAIR

1.0 GENERAL

1.01 SECTION INCLUDES

A Repairing streets, highways, driveways, sidewalks, and other pavements that have been cut, broken, or otherwise damaged during construction.

B Repairing areas of failed paving in preparation forresurfacing.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 01500 – Temporary Facilities and Controls
4. Section 02335 – Subgrade
5. Section 02710 – Base Course for Pavement
6. Section 02330 – Embankment
7. Section 01140 – Contractor's Use of Premises

1.02 MEASUREMENT AND PAYMENT

A Unless indicated as a Bid Item, no separate payment will be made for pavement repair under this section. Include cost in Bid Items for which this Work is a component.

B If pavement repair is included as a Bid Item, measurement is on a square yard basis. as follows:
1. Trench width plus 48 inches for utilities.
2. Trench width plus 10 feet for structures.
3. As marked in field for failed paving.

C If provisions of this Section, 3.01D, require the limits of pavement repairs to be increased, then the payment limits shall be increased to the same extent.

D No payment will be made for work outside payment limits, in areas that are not specifically called out as pay items and are incidental to the work or in areas removed for Contractor's convenience.

E Refer to Section 01200 - Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make submittals required by this section under the provisions of Section 01350 – Submittals.

1.04 PROTECTION OF PEOPLE AND PROPERTY

A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

2.0 PRODUCTS

2.01 MATERIALS

A Provide materials of the same character as existing materials encountered in a cross section of the area to be repaired, or as approved by the Engineer.

B Subgrade: Provide on-site soil stabilized with lime, lime fly ash, etc., as required by the testing laboratory under the provisions of Section 02335 – Subgrade.

C Base: Provide new base material as required by applicable portions of Section 02710 – Base Course for Pavement.

D Pavement: Provide new paving materials as required by Technical Specifications of applicable surface course treatments.

3.0 EXECUTION

3.01 EXAMINATION

A Verify backfill is complete before repairing pavement over installed utilities or structures.

B Verify remaining subgrade is ready to support imposed loads before repairing areas of failed paving.

3.02 PREPARATION

A For installation of utilities and utility appurtenances, saw cut and remove pavement (including base material for asphalt paving) 24 inches beyond the width of excavation, unless otherwise indicated on Plans.

B For installation of structures, saw cut and remove pavement (including base material for asphalt paving) 5 feet beyond the width of excavation, unless otherwise indicated on Plans.

C For repair of areas of failed paving, saw cut and remove pavement (including base material for asphalt paving) where indicated in the field or as directed by Engineer. Remove subgrade that is soft and yielding, or to depth as directed by Engineer.

D If removed pavement is greater than one-half of pavement lane width, or within 18 inches of a longitudinal joint, on concrete pavement, replace pavement for full lane width or to nearest longitudinal joint as approved by the Engineer.

E Protect edges of existing pavement to remain from damage during removals, utility placement, backfill, and paving operations. For concrete pavement, leave and protect minimum of 18 inches of undisturbed subgrade on each side of trench to support replacement slab.

3.03 EXAMINATION:

A Verify backfill is complete before repairing pavement over installed utilities or structures.

B Verify remaining subgrade is ready to support imposed loads before repairing areas of failed paving.

3.04 INSTALLATION

A Replace subgrade with material specified in this Section, 2.01B. Place and compact under the provisions of Section 02330 – Embankment for areas under future paving to match lines and grade of surrounding subgrade.

B Replace base course with material specified in this Section, 2.01C. Place and compact under the provisions of Section 02710 – Base Course for Pavement to match lines and grade of surrounding base course.

C Replace pavement with material specified in this Section, 2.01D, and according to the Technical Specifications of the particular surface course treatment so that a smooth, hard, well cemented surface, conforming to the lines and grade of the surround pavement is secured

D For concrete pavement, install size and length of reinforcing steel and pavement thickness indicated on Plans. Place types and spacing of joints to match existing or as indicated on Plans.

E Where existing pavement consists of concrete pavement with asphaltic surfacing, resurface with minimum 2-inch depth asphaltic pavement.

F Repair state highway crossings in accordance with highway department permit and within 1 week after utility work is installed.

3.05 CLEAN-UP AND RESTORATION

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

3.06 PROTECTION OF THE WORK

A Protect and maintain all pavement in good condition until completion of Work.

B Replace pavement damaged by Contractor's operations at no cost to Owner.

END OF SECTION

Section 02981

BLAST CLEANING OF PAVEMENT

1.0 GENERAL

1.01 SECTION INCLUDES

A Removal of existing pavement markings.

B Preparation of pavement surfaces for new pavement markings.

C References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals

1.02 MEASUREMENT AND PAYMENT

A Measurement for blast cleaning of lines is on a linear foot basis for each width, measured and complete in place.

B Measurement for blast cleaning of symbols and legends is on a square foot basis, measured and complete in place.

C Payment includes all labor and materials required to complete blast cleaning where indicated on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit description and characteristics of proposed blasting medium and equipment for approval.

2.0 PRODUCTS

2.01 MATERIALS

A Blasting Media: Approved quality commercial product capable of producing specified surface cleanliness without deposition of deleterious materials on cleaned pavement surface. Do not use high silica content sand that may result in high levels of free crystalline silica dust particles as a blasting agent.

2.02 EQUIPMENT

A Equipment shall be power driven and of sufficient capacity to clean the pavement surface to specified cleanliness. Equipment shall utilize moisture and oil traps of

sufficient capacity to remove contaminants from the air and prevent deposition of moisture, oil or other contaminants on the pavement surface.

3.0 EXECUTION

3.01 REMOVAL OF EXISTING MARKINGS

A Remove pavement markings where necessary to prevent driver confusion, or where indicated on drawings. Included are areas where it will be necessary for drivers to cross existing markings which they would not normally cross. Remove or obliterate markings to the satisfaction of the Engineer. Do not damage pavement surface.

3.02 CLEANING FOR PLACEMENT OF MARKERS

A Remove old pavement markings, loose material, and other contaminants deleterious to the adhesion of new pavement markings to be placed. On Portland cement concrete pavement, minimize over-blasting to prevent damage to pavement surface. Small particles of tightly adhering existing pavement markings may remain if complete removal will result in pavement surface damage.

B Follow manufacturer's written instructions for proper cleaning of pavement surfaces to receive pavement marking.

END OF SECTION

Section 02985

FIBER OPTICS

1.0 GENERAL

1.01 SECTION INCLUDES

A. Technical specification and bid items for fiber optics as shown in the ***attachment A***

1.02 UNIT PRICES

A. See the **attachment A** for unit price

1.03 SYSTEM DESCRIPTION

A. See **attachment A** for detail

1.04 SUBMITTALS

A. Submit shop drawings under provisions of Section 01350 - Submittal Procedures.

2.0 PRODUCTS

2.01 FIBER OPTICS MATERIALS

A. See **attachment A** for detail

3.0 EXECUTION

3.01 INSTALLATION

A. See the **attachment A** for detail.

END OF SECTION

ATTACHMENT A

BID ITEM 0001

Data Sheet

Cisco Industrial Ethernet 4000 Series Switches

Developed specifically to withstand the harshest industrial manufacturing environments, these switches offer today's most flexible and scalable industrial Ethernet platform that will grow with your network.

Product Overview

The Cisco® Industrial Ethernet (IE) 4000 Series is the latest addition to our ruggedized switching platforms and provides superior high-bandwidth switching and proven Cisco IOS® Software-based routing capabilities for industrial environments. The IE 4000 Series delivers highly secure access and industry-leading convergence using the Cisco Resilient Ethernet Protocol (REP) and is built to withstand extreme environments while adhering to overall IT network design, compliance, and performance requirements.

The IE 4000 Series is ideal for industrial Ethernet applications where hardened products are required, including factory automation, energy and process control, intelligent transportation systems (ITS), oil and gas field sites, city surveillance programs, and mining. With improved overall performance, greater bandwidth, a richer feature set, and enhanced hardware, the Cisco IE 4000 Series complements the current industrial Ethernet portfolio of related Cisco industrial switches, such as the Cisco IE 2000 and IE 3000.

The Cisco IE 4000 can easily be installed in your network. Through a user-friendly web device manager, the Cisco IE 4000 provides easy out-of-the-box configuration and simplified operational manageability to deliver advanced security, data, video, and voice services over industrial networks.

Features and Benefits

Table 1. Features and Benefits of Cisco IE 4000

Feature	Benefit
Robust Industrial Design	• Built for harsh environment and temperature range (-40 to 70 C). • Hardened for vibration, shock and surge, and noise immunity. • Resilient dual ring design via 4x Gigabit Ethernet uplink ports. • Complies with multi-industry specifications for automation, ITS, and substation environments. • Improves uptime, performance, and safety of industrial systems and equipment. • Fitted with compact, PLC (Programmable Logic Control) style DIN rail compliant form factor ideal for industrial deployment. • Covers a wide range of Power over Ethernet (PoE) application requirements.
User-Friendly GUI Device Manager	• Allows easily configuration and monitoring via a web browser. • Eliminates the need for more complex terminal emulation programs. • Reduces the cost of deployment.
SwapDrive: "Zero-Config" Replacement	• Simple switch replacement in case of a failure. • No networking expertise required. • Helps ensure fast recovery.
High-Density Industrial Power over Ethernet (PoE)	• Reduces complexity with one cable for both connectivity and power. • Controls costs by limiting wiring, distribution panels, and circuit breakers. • Creates space and reduces heat dissipation. • Enables ready-to-use PoE devices like IP phones and wireless access points. • Supports (on select models) maximum HD camera deployments.

Feature	Benefit
Full Gigabit Ethernet Switch	• Connects new wireless access point (802.11n and 802.11ac). • Enables new HD IP Cameras and new PLC (Programmable Logic Control). • Allows SCADA (Supervisory Control And Data Acquisition) connectivity. • Provides introduction of new bandwidth-hungry applications in the industrial space. • Supports very-delay-sensitive applications and time-sensitive networks. • Delivers multiple rings, redundant ring topology for new network configurations. • Extends geographical scalability where longer distance connectivity is required.

Your Ruggedized Choice for Industrial Environments

The Cisco Industrial Ethernet (IE) 4000 Series offers:

- Bandwidth and capacity to grow with your networking needs: 20-Gbps nonblocking switching capacity with up to 20 Gigabit Ethernet ports per switch
- High-density industrial PoE/PoE+ support providing in-line power to up to 8 power devices, including IP cameras and phones, badge readers, wireless access points, etc.
- Cisco IOS Software features for smooth IT integration and policy consistency
- Robust resiliency enabled by dual ring design via 4x Gigabit Ethernet uplink ports, Resilient Ethernet Protocol (REP), Parallel Redundancy Protocol (PRP), PROFINET– Media Redundancy Protocol (MRP), Etherchannel and Flexlink support, redundant power input, dying gasp, etc.
- True zero-touch replacement for middle-of-the-night or middle-of-nowhere failure
- Line-rate, low-latency forwarding with advanced hardware assist features (such as NAT, IEEE1588)
- Simplified software upgrade path with universal images
- Support of Industrial automation protocols EtherNet/IP (CIP) and PROFINET, MRP (IEC 62439-2)

Figure 1 shows switch models, Table 2 shows all the available Cisco IE 4000 Series models, Table 3 list the SW license PIDs and Table 4 lists the power supplies for Cisco IE 4000 Series Switches.

Figure 1. IE 4000 Models

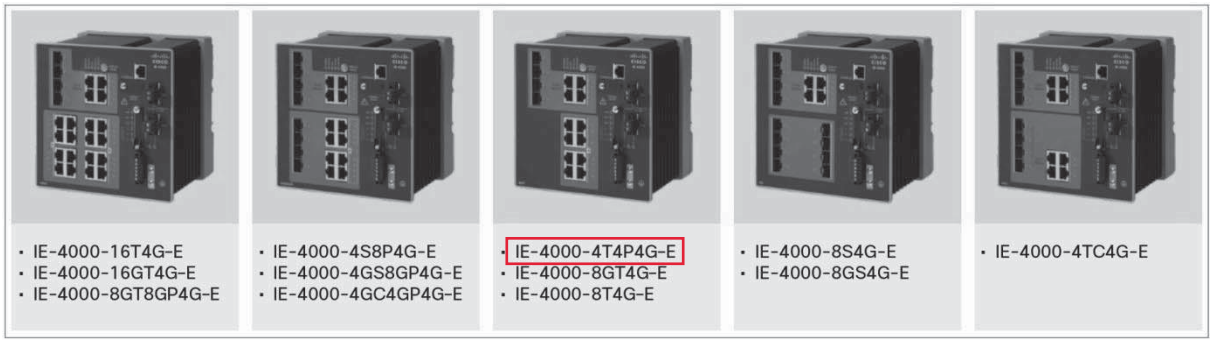


Table 2. Cisco IE 4000 Series Models

Product Number	Total Ports	GE Combo Uplinks (4G)[1]	Additional Combo Ports	RJ-45 Copper Ports (T)	SFP Fiber Ports (S)	PoE/PoE+ Ports (P, GP)	Default Software
IE-4000-4TC4G-E	8	All models have 4 GE combo uplink ports	4 (FE)				All models ship with LAN Base image[2]
IE-4000-8T4G-E	12			8 (FE)			
IE-4000-8S4G-E	12				8 (FE)		
IE-4000-4T4P4G-E	12			4 (FE)		4 (FE)	
IE-4000-16T4G-E	20			16 (FE)			
IE-4000-4S8P4G-E	16				4 (FE)	8 (FE)	
IE-4000-8GT4G-E	12			8 (GE)			
IE-4000-8GS4G-E	12				8 (GE)		
IE-4000-4GC4GP4G-E	12		4 (GE)			4 (GE)	
IE-4000-16GT4G-E	20			16 (GE)			
IE-4000-8GT8GP4G-E	20			8 (GE)		8 (GE)	
IE-4000-4GS8GP4G-E	16				4 (GE)	8 (GE)	

[1] Combo ports provide one copper and one fiber physical port and only one can be activated at a time.
[2] Can be upgraded to IP Services at a fee.

Table 3. Cisco IE 4000 SW License and Accessories PIDs

License	Description
L-IE4000-RTU=	IE4000 Electronic software license upgrade from LAN base to IP Services
LIC-MRP-Manager	MRP ring manager license
LIC-MRP-Client	MRP ring client license
LIC-MRP-MULTI-MGR	Multiple MRP manger license
STK-RACKMNT-2955=	19" DIN Rail mount kit
STK-RACK-DINRAIL=	19" DIN Rail mount kit

All copper Gigabit Ethernet interfaces support speed negotiation to 10/100/1000 mbps and duplex negotiation. All copper Fast Ethernet interfaces support speed negotiation to 10/100 mbps and duplex negotiation.

Table 4. Power Supplies for Cisco IE 4000 Series Switches

Product Number	Wattage	Rated Nominal Input Operating Range	Supported Input Voltage Operating Range	Power Output	PoE/PoE + Support	Use Case Scenario
PWR-IE170W- PC-AC=	170W	AC 100-240V/2.3A 50-60Hz or DC 125-250V/2.1A	AC 90-264V or DC 106-300V	54VDC/3.15A	Yes	Maximum PoE/PoE+ port support in a AC or high DC environment[1]
PWR-IE170W- PC-DC=	170W	DC 12-54V/23A	DC 10.8-60V	54VDC/3.15A	Yes	Maximum PoE/PoE+ port support in a DC environment[1]
PWR-IE50W- AC=	50W	AC 100-240V/1.25A 50-60Hz or DC 125-250V/1.25A	AC 90-264V or DC 106-300V	24VDC/2.1A	No	No PoE/PoE+ support needed in an AC or DC environment
PWR-IE50W- AC-IEC=	50W	AC 100-240V/1.25A 50-60Hz	AC 90-264V	24VDC/2.1A	No	No PoE/PoE+ support needed when IEC plug is desired

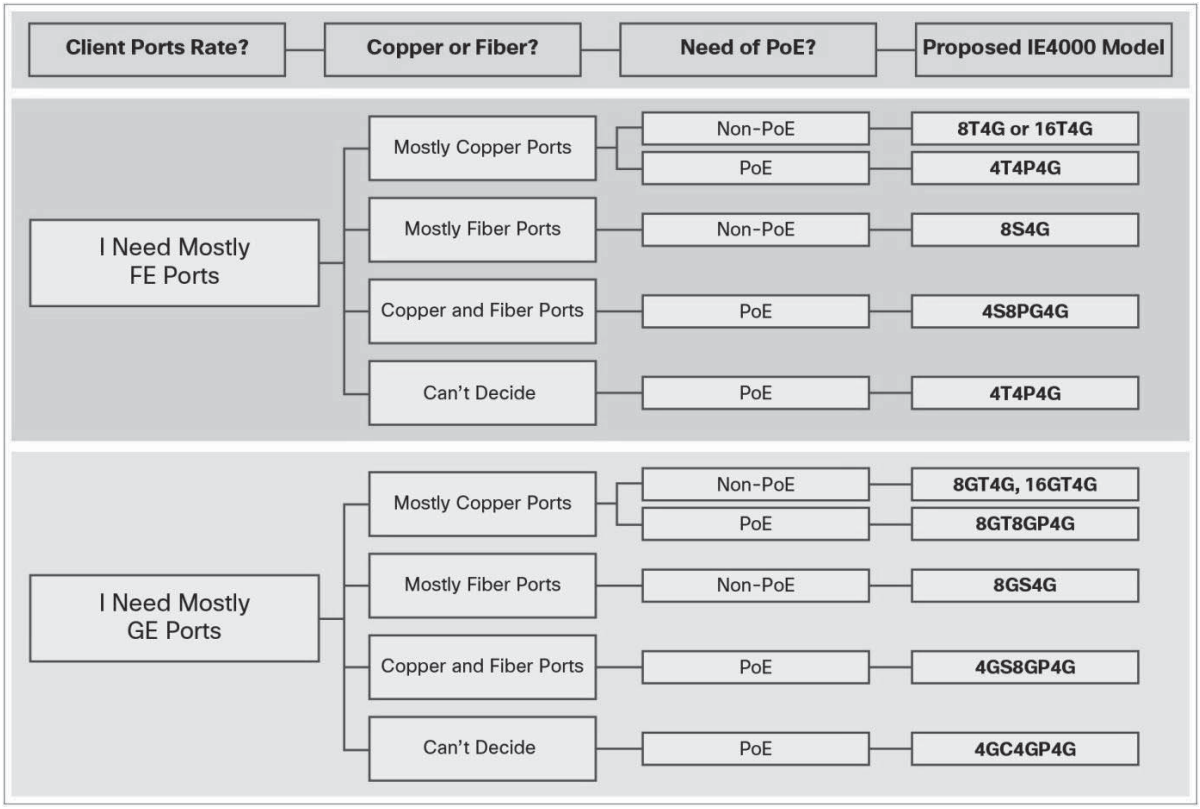
Product Number	Wattage	Rated Nominal Input Operating Range	Supported Input Voltage Operating Range	Power Output	PoE/PoE + Support	Use Case Scenario
PWR-IE65W- PC-AC=	65W	AC 100-240V/1.4A 50-60Hz or DC 125-250V/1.0A	AC 90-264V or DC 106-300V	54VDC/1.2 A	Yes	Minimum (1~2 port) PoE support needed in an AC or high DC environment[2]
PWR-IE65W- PC-DC=	65W	DC 24-48VDC/4.5A	DC 18-60V	54VDC/1.2 A	Yes	Minimum (1~2 port) PoE support needed in a DC environment2

[1] The entire power budget for the switch and PoE ports needs to stay within 170W. A PoE port draws up to 15.4W of power, and a PoE+ port draws up to 30W of power.

[2] The entire power budget for the switch and PoE ports needs to stay within 65W.

Figure 2 shows a diagram to help you select a Cisco IE 4000 model.

Figure 2. Cisco IE 4000 Model Selection Guide



Product Specifications

Table 5 lists specifications, Table 6 gives information about switch performance and scalability, Table 7 and 8 list important software features, Table 9 lists compliance specifications, and Table 10 gives information about management and standards of the Cisco IE 4000 Series Switches.

Table 5. Product Specifications

Description	Specification
Hardware	• 1GB DRAM • 128-MB onboard flash memory • 1-GB removable SD flash memory card • Mini-USB connector • RJ-45 connector
Alarm	• Alarm I/O: two alarm inputs to detect dry contact open or closed, one alarm output relay
Power Input	• Redundant DC input voltage with operating range: nominal 9.6 to 60VDC • Maximum DC input current: 3.7A (IE-4000-4T4P4G-E, IE-4000-8T4G-E, IE-4000-8GT4G-E, IE-4000-16T4G-E), 4.3A (IE- 4000-4GC4GP4G-E, IE-4000-4TC4G-E, IE-4000-4S8P4G-E, IE-4000-4GS8GP4G-E, IE-4000-16GT4G-E, IE- 4000-8GT8GP4G-E), 5A (IE-4000-8S4G-E, IE-4000-8GS4G-E)
Power Consumption	• IE-4000-4T4P4G-E, IE-4000-8T4G-E, IE-4000-8GT4G-E, and IE-4000-16T4G-E: 35W • IE-4000-4GC4GP4G-E, IE-4000-4TC4G-E, IE-4000-4S8P4G-E, IE-4000-4GS8GP4G-E, and IE-4000-16GT4G-E: 40W • IE-4000-8S4G-E, IE-4000-8GS4G-E: 42W • These numbers are measured at 9.6V and do not include PoE power consumption
Dimensions, (H x W x D)	• All IE 4000 models have the following dimensions: 6.12 x 6.12 x 5.09 in. (155.4 x 155.4 x 129.2 mm) • PWR-IE170W-PC-AC=: 5.93 x 3.72 x 5.60 in. (150.6 x 94.5 x 142.2) • PWR-IE170W-PC-DC=: 5.93 x 4.47 x 5.75 in. (150.6 x 113.5 x 145.8) • PWR-IE50W-AC=: 5.8 x 2.0 x 4.4 in. (147 x 51 x 112 mm) • PWR-IE50W-AC-IEC=: 5.8 x 2.0 x 4.4 in. (147 x 51 x 112 mm) • PWR-IE65W-PC-AC=: 5.9 x 2.6 x 4.6 in. (150 x 66 x 117 mm) • PWR-IE65W-PC-DC=: 5.9 x 2.6 x 4.6 in. (150 x 66 x 117 mm)
Weight	• All IE4000 models listed in Table 1: 6.35 pounds (2.88 kg) • PWR-IE170W-PC-AC=: 3.88 pounds (1.76 kg) • PWR-IE170W-PC-DC=: 3.7 pounds (1.67 kg) • PWR-IE50W-AC=: 1.4 lb (0.65 kg) • PWR-IE50W-AC-IEC=: 1.4 lb (0.65 kg) • PWR-IE65W-PC-DC=: 2.6 (1.18 Kg) • PWR-IE65W-PC-AC=: 2.7 (1.24 Kg)

Table 6. Switch Performance and Scalability

Description	Specification
Forwarding rate	Line rate for all ports and all packet sizes
Number of queues	4 egress
Unicast MAC addresses	16,000
IGMP multicast groups	1,000
Number of VLANs	1,000
IPv4 MAC security ACEs	1,000 with default TCAM Template
NAT translation	Bidirectional, 128 unique subnet NAT translation entries, which can expand to tens of thousands of translated entries if designed properly

Table 7. Cisco IE 4000 LAN BASE: Key Software Features

LAN Base License (Default)	Features
Layer 2 Switching	IEEE 802.1, 802.3, 802.3at, 802.3af standard, VTPv2, NTP, UDLD, CDP, LLDP, Unicast Mac filter, Flexlink, Resilient Ethernet Protocol (REP), Parallel Redundancy Protocol (PRP), VTPv3, EtherChannel, Voice VLAN, qinq tunneling
Security	SCP, SSH, SNMPv3, TACACS+, RADIUS Server/Client, MAC Address Notification, BPDU Guard, Port-Security, Private VLAN, DHCP Snooping, Dynamic ARP Inspection, IP Source Guard, 802.1x, Guest VLAN, MAC Authentication Bypass, 802.1x Multi-Domain Authentication, Storm Control, Trust Boundary, Cisco TrustSec® supporting SGT inline tagging and SGACL, FIPS 140-2
Layer 2 Multicast	IGMPv1, v2, v3 Snooping, IGMP filtering, IGMP Querier
Management	Fast Boot, Express Setup, Web Device Manager, Cisco Network Assistant[1], Cisco Prime™ platform1, MIB, SmartPort, SNMP, syslog, Storm Control - Unicast, Multicast, Broadcast, SPAN Sessions, RSPAN, DHCP Server, Customized TCAM/SDM size configuration, DOM (digital optical management)
Industrial Ethernet	CIP Ethernet/IP, Profinet v2 MRP (IEC 62439-2), IEEE 1588 PTP v2, NTP to PTP translation, CIP Time Sync
Quality of Service	Ingress Policing, Rate-Limit, Egress Queueing/shaping, AutoQoS, Modular QoS CLI (MQC)
Layer 2 IPv6	IPv6 Host support, HTTP over IPv6, SNMP over IPv6
Layer 3 Routing	IPv4 Static Routing
Industrial Management	Layer 2 switching with 1:1 static Network Address Translation (NAT)
Utility	Power Profile, dying gasp, GOOSE messaging, SCADA protocol classification, MODBUS TCP/IP, utility SmartPort macro, BFD, Ethernet OAM, IEEE 802.3ah, CFM (IEEE 802.1ag)

[1] Support after product General Availability

Table 8. Cisco IE 4000 IP Services: Key Software Features

IP Services License	Additional Features
IP Multicast	PIM sparse mode (PIM-SM), PIM dense mode (PIM-DM), and PIM sparse-dense mode
Industrial Management	Embedded Event Manager (EEM)
IP Unicast Routing Protocols	OSPF, EIGRP, BGPv4, IS-IS, RIPv2, Policy-Based Routing (PBR), HSRP
Cisco Express Forwarding	Hardware routing architecture delivers extremely high-performance IP routing
IPv6 Routing	RIPng, OSPFv6, and EIGRPv6 support
Security	IEEE 802.1AE MACsec, Security Group Access Control Lists (SGACL)
Virtualization	VRF-lite

To enable PROFINET MRP (IEC 62439-2) functionalities on the IE4000 switches the relevant SW license, listed in table 3 should be ordered.

Table 9. Compliance Specifications

Type	Standards
Electromagnetic Emissions	FCC 47 CFR Part 15 Class A EN 55022A Class A VCCI Class A AS/NZS CISPR 22 Class A CISPR 11 Class A CISPR 22 Class A ICES 003 Class A CNS13438 Class A KN22
Electromagnetic Immunity	EN55024 CISPR 24 AS/NZS CISPR 24

Type	Standards
	KN24 EN 61000-4-2 Electro Static Discharge EN 61000-4-3 Radiated RF EN 61000-4-4 Electromagnetic Fast Transients N 61000-4-5 Surge EN 61000-4-6 Conducted RF EN 61000-4-8 Power Frequency Magnetic Field EN 61000-4-9 Pulse Magnetic Field EN 61000-4-11 AC Power Voltage EN 61000-4-18 Damped Oscillatory Wave EN-61000-4-29 DC Voltage Dips
Industry Standards	EN 61000-6-1 Light Industrial EN 61000-6-2 Industrial EN 61000-6-4 Industrial EN 61326 Industrial Control EN 61131-2 Programmable Controllers Substation KEMA (IEEE 1613, IEC 61850-3) NEMA TS-2 (EMC, environmental, mechanical) IEEE 1613 Electric Power Stations Communications Networking IEC 61850-3 Electric Substations Communications Networking EN50155 Railway - Electronic Equipment on Rolling Stock (EMC, ENV, Mech) EN50121-4 Railway - Signaling and Telecommunications Apparatus EN50121-3-2 Railway - Apparatus for Rolling Stock ODVA Industrial EtherNet/IP PROFINET conformance B IP30 (per EN60529)
Safety Standards and Certifications	**Information Technology Equipment:** UL/CSA 60950-1 EN 60950-1 CB to IEC 60950-1 with all country deviations NOM to NOM-019-SCFI (through partners and distributor) **Industrial Floor (Control Equipment):** UL 508 CSA C22.2, No 142 **Hazardous Locations:** ANSI/ISA 12.12.01 CSA C22.2 No 213 IEC 60079-0, -15 IECEx test report EN 60079-0, -15 ATEX certification (Class I Zone 2) Cabinet enclosure required
Operating Environment	Operating Temperature: -40C to +75C • -40C to +70C (Vented Enclosure Operating) • -40C to +60C (Sealed Enclosure Operating) • -34C to +75C (Fan or Blower equipped Enclosure Operating) EN 60068-2-1 EN 60068-2-2 EN 61163 Altitude: up to 15,000 feet
Storage Environment	Temperature: -40 to +85 degrees C Altitude: 15,000 feet IEC 60068-2-14
Humidity	Relative humidity of 5% to 95% non-condensing IEC 60068-2-3 IEC 60068-2-30
Shock and Vibration	IEC 60068-2-27 (operational shock, 50G, 11ms, Half Sine) IEC 60068-2-27 (Non-Operational Shock, 65-80G, 9ms, Trapezoidal) IEC 60068-2-6, IEC 60068-2-64, EN 61373 (Operational Vibration) IEC 60068-2-6, IEC 60068-2-64, EN 61373 (Non-operational Vibration)

Type	Standards
Corrosion	ISO 9223: Corrosion class C3-Medium class C4-High EN 60068-2-52 (Salt Fog) EN 60068-2-60 (Flowing Mixed Gas)
Others	RoHS Compliance China RoHS Compliance TAA (Government) CE (Europe)
Warranty	Five-year limited HW warranty on all IE-4000 PIDs and all IE Power Supplies (see table 3 above). See link below for more details on warranty
Mean Time Between Failure (MTBF)	IE-4000-4TC4G-E: 578, 730 Hours IE-4000-8T4G-E: 591, 070 Hours IE-4000-8S4G-E: 583, 700 Hours IE-4000-4T4P4G-E: 562, 300 Hours IE-4000-16T4G-E: 558, 310 Hours IE-4000-4S8P4G-E: 535, 880 Hours IE-4000-8GT4G-E: 591, 240 Hours IE-4000-8GS4G-E: 583, 700 Hours IE-4000-4GC4GP4G-E: 550, 940 Hours IE-4000-16GT4G-E: 558, 630 Hours IE-4000-8GT8GP4G-E: 519, 190 Hours IE-4000-4GS8GP4G-E: 536, 220 Hours

Table 10. Management and Standards

Description	Specification	
IEEE Standards	• IEEE 802.1D MAC Bridges, STP • IEEE 802.1p Layer2 COS prioritization • IEEE 802.1q VLAN • IEEE 802.1s Multiple Spanning-Trees • IEEE 802.1w Rapid Spanning-Tree • IEEE 802.1x Port Access Authentication • IEEE 802.1AB LLDP • IEEE 802.3ad Link Aggregation (LACP) • IEEE 802.3af Power over Ethernet provides up to 15.4W DC power to each end device • IEEE 802.3at Power over Ethernet provides up to 25.5W DC power to each end device	• IEEE 802.3af Power over Ethernet • IEEE 802.3at Power over Ethernet Plus • IEEE 802.3ah 100BASE-X SMF/MMF only • IEEE 802.3x full duplex on 10BASE-T • IEEE 802.3 10BASE-T specification • IEEE 802.3u 100BASE-TX specification • IEEE 802.3ab 1000BASE-T specification • IEEE 802.3z 1000BASE-X specification • IEEE 1588v2 PTP Precision Time Protocol
RFC Compliance	• RFC 768: UDP • RFC 783: TFTP • RFC 791: IPv4 protocol • RFC 792: ICMP • RFC 793: TCP • RFC 826: ARP • RFC 854: Telnet • RFC 951: BOOTP • RFC 959: FTP • RFC 1157: SNMPv1 • RFC 1901,1902-1907 SNMPv2 • RFC 2273-2275: SNMPv3 • RFC 2571: SNMP Management • RFC 1166: IP Addresses • RFC 1256: ICMP Router Discovery	• RFC 1305: NTP • RFC 1492: TACACS+ • RFC 1493: Bridge MIB Objects • RFC 1534: DHCP and BOOTP interoperation • RFC 1542: Bootstrap Protocol • RFC 1643: Ethernet Interface MIB • RFC 1757: RMON • RFC 2068: HTTP • RFC 2131, 2132: DHCP • RFC 2236: IGMP v2 • RFC 3376: IGMP v3 • RFC 2474: DiffServ Precedence • RFC 3046: DHCP Relay Agent Information Option • RFC 3580: 802.1x RADIUS • RFC 4250-4252 SSH Protocol

Description	Specification	
SNMP MIB Objects	• BRIDGE-MIB • CALISTA-DPA-MIB • CISCO-ACCESS-ENVMON-MIB • CISCO-ADMISSION-POLICY-MIB • CISCO-AUTH-FRAMEWORK-MIB • CISCO-BRIDGE-EXT-MIB • CISCO-BULK-FILE-MIB • CISCO-CABLE-DIAG-MIB • CISCO-CALLHOME-MIB • CISCO-CAR-MIB • CISCO-CDP-MIB • CISCO-CIRCUIT-INTERFACE-MIB • CISCO-CLUSTER-MIB • CISCO-CONFIG-COPY-MIB • CISCO-CONFIG-MAN-MIB • CISCO-DATA-COLLECTION-MIB • CISCO-DHCP-SNOOPING-MIB • CISCO-EMBEDDED-EVENT-MGR-MIB • CISCO-ENTITY-ALARM-MIB • CISCO-ENTITY-VENDORTYPE-OID-MIB • CISCO-ENVMON-MIB • CISCO-ERR-DISABLE-MIB • CISCO-FLASH-MIB • CISCO-FTP-CLIENT-MIB • CISCO-IF-EXTENSION-MIB • CISCO-IGMP-FILTER-MIB • CISCO-IMAGE-MIB • CISCO-IP-STAT-MIB • CISCO-LAG-MIB • CISCO-LICENSE-MGMT-MIB • CISCO-MAC-AUTH-BYPASS-MIB • CISCO-MAC-NOTIFICATION-MIB • CISCO-MEMORY-POOL-MIB • CISCO-PAE-MIB • CISCO-PAGP-MIB • CISCO-PING-MIB • CISCO-PORT-QOS-MIB • CISCO-PORT-SECURITY-MIB • CISCO-PORT-STORM-CONTROL-MIB • CISCO-PRIVATE-VLAN-MIB • CISCO-PROCESS-MIB • CISCO-PRODUCTS-MIB • CISCO-RESILIENT-ETHERNET-PROTOCOL-MIB • CISCO-RTTMON-ICMP-MIB • CISCO-RTTMON-IP-EXT-MIB • CISCO-RTTMON-MIB • CISCO RTTMON-RTP-MIB	• CISCO-SNMP-TARGET-EXT-MIB • CISCO-STACK-MIB • CISCO-STACKMAKER-MIB • CISCO-STP-EXTENSIONS-MIB • CISCO-SYSLOG-MIB • CISCO-TCP-MIB • CISCO-UDLDP-MIB • CISCO-VLAN-IFTABLE-RELATIONSHIP-MIB • CISCO-VLAN-MEMBERSHIP-MIB • CISCO-VTP-MIB • ENTITY-MIB • ETHERLIKE-MIB • HC-RMON-MIB • IEEE8021-PAE-MIB • IEEE8023-LAG-MIB • IF-MIB • IP-FORWARD-MIB • LLDP-EXT-MED-MIB • LLDP-EXT-PNO-MIB • LLDP-MIB • NETRANGER • NOTIFICATION-LOG-MIB • OLD-CISCO-CHASSIS-MIB • OLD-CISCO-CPU-MIB • OLD-CISCO-FLASH-MIB • OLD-CISCO-INTERFACES-MIB • OLD-CISCO-IP-MIB • OLD-CISCO-MEMORY-MIB • OLD-CISCO-SYS-MIB • OLD-CISCO-SYSTEM-MIB • OLD-CISCO-TCP-MIB • OLD-CISCO-TS-MIB • RMON-MIB • RMON2-MIB • SMON-MIB • SNMP-COMMUNITY-MIB • SNMP-FRAMEWORK-MIB • SNMP-MPD-MIB • SNMP-NOTIFICATION-MIB • SNMP-PROXY-MIB • SNMP-TARGET-MIB • SNMP-USM-MIB • SNMP-VIEW-BASED-ACM-MIB • SNMPv2-MIB • TCP-MIB • UDP-MIB	

Table 11. SFP Support

Part Number	Specification	SFP Type	Max Distance	Cable Type	Temp Range*	DOM Support
GLC-FE-100FX-RGD=	100BASE-FX	FE	2km	MMF	IND	Yes
GLC-FE-100LX-RGD	100BASE-LX10	FE	10km	SMF	IND	Yes
GLC-FE-100FX=	100BASE-FX	FE	2km	SMF	COM	No
GLC-FE-100LX=	100BASE-LX10	FE	10km	SMF	COM	No
GLC-FE-100EX=	100BASE-EX	FE	40km	SMF	COM	No
GLC-FE-100ZX=	100BASE-ZX	FE	80km	SMF	COM	No
GLC-FE-100BX-D=	100BASE-BX10	FE	10km	SMF	COM	No
GLC-FE-100BX-U=	100BASE-BX10	FE	10km	SMF	COM	Yes
GLC-SX-MM-RGD=	1000BASE-SX	GE	550m	MMF	IND	Yes
GLC-LX-SM-RGD=	1000BASE-LX/LH	GE	550m/10km	MMF/SMF	IND	Yes
GLC-ZX-SM-RGD=	1000BASE-ZX	GE	70km	SMF	IND	Yes
GLC-BX40-U-I=	1000BASE-BX40	GE	40km	SMF	IND	Yes
GLC-BX40-D-I=	1000BASE-BX40	GE	40km	SMF	IND	Yes
GLC-BX40-DA-I=	1000BASE-BX40	GE	40km	SMF	IND	Yes
GLC-BX80-U-I=	1000BASE-BX80	GE	80km	SMF	IND	Yes
GLC-BX80-D-I=	1000BASE-BX80	GE	80km	SMF	IND	Yes
GLC-SX-MMD=	1000BASE-SX	GE	550m	MMF	EXT	Yes
GLC-LH-SMD=	1000BASE-LX/LH	GE	550m/10km	MMF/SMF	EXT	Yes
GLC-EX-MMD=	1000BASE-EX	GE	40km	SMF	EXT	Yes
GLC-ZX-MMD=	1000BASE-ZX	GE	70km	SMF	EXT	Yes
GLC-BX-D=	1000BASE-BX10	GE	10km	SMF	COM	Yes
GLC-BX-U=	1000BASE-BX10	GE	10km	SMF	COM	Yes
CWDM-SFP-xxxx= (8 freq)	CWDM 1000BASE-X	GE		SMF	COM	Yes
DWDM-SFP-xxxx= (40 freq)	DWDM 1000BASE-X	GE		SMF	COM	Yes
SFP-GE-S=	1000BASE-SX	GE	550m	MMF	EXT	Yes
SFP-GE-L=	1000BASE-LX/LH	GE	550m/10km	MMF/SMF	EXT	Yes
SFP-GE-Z=	1000BASE-ZX	GE	70km	SMF	EXT	Yes
GLC-SX-MM=	1000BASE-SX	GE	550m	MMF	COM	No
GLC-LH-SM=	1000BASE-LX/LH	GE	550m/10km	MMF/SMF	COM	No
GLC-ZX-SM=	1000BASE-ZX	GE	70km	SMF	COM	Yes
GLC-TE=	1000BASE-T	GE	100m	Copper	EXT	NA
GLC-T=	1000BASE-T	GE	100m	Copper	COM	NA

Note: Not all SFPs supported in all SW versions. For first software release supporting SFP refer to http://www.cisco.com/en/US/products/hw/modules/ps5455/products_device_support_tables_list.html

* If non industrial (i.e., EXT, COM) SFPs are used the switch operating temperature must be derated.

MMF = multi-mode fiber

SMF = single-mode fiber

Warranty Information

Warranty information for the IE 4000 is available on http://www.cisco-servicefinder.com/warrantyfinder.aspx.

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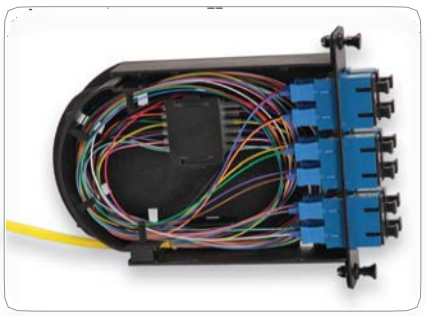
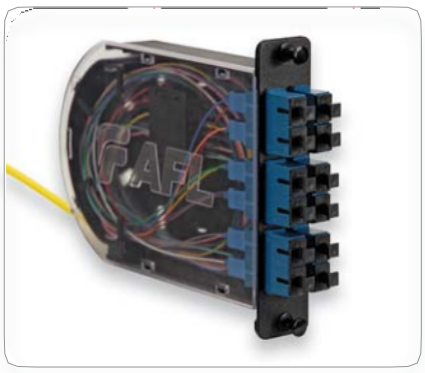
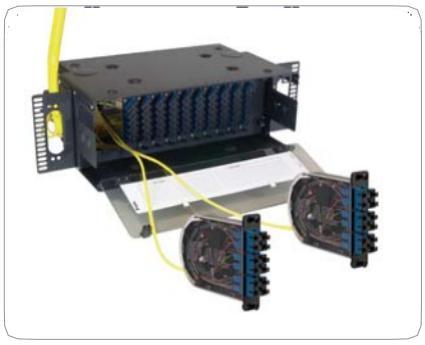


12-Fiber SC/UPC configuration



DAS Poli-MOD



Poli-MOD® Patch and Splice Module

AFL's new Poli-MOD is an innovative patch and splice module, which offers an inventive and effective means to accommodate up to 24 fiber interconnections in an industry-standard, single-slot LGX®118 footprint. The new Poli-MOD offers a unique and robust way to secure cable without the need for time-wasting, tie-wrap alternatives. Additionally, the module leverages a creative snap-in splice sleeve cradle to securely manage both single and ribbon fiber arrangements. These features provide the capacity to outfit a standard 4RU rack-mount panel with up to 288-fiber interconnections.

The Poli-MOD is also offered in an arrangement that supports the low loss budget requirements of Distributed Antenna System (DAS) networks. This is accomplished through the elimination of an interconnection point while providing a robust splicing environment for rack and wall-mount panel applications.

Features

- 24-fiber interconnection capacity
- LGX 118 compatibility (single-slot module)
- Effective and time-saving cable mounting mechanism (no tie-wraps necessary)
- Inventive splice sleeve cradle
- Available in SC, LC, ST and FC connector arrangements
- Organized fiber routing
- Fixed solution, no moving parts
- Multi-directional cable entry access
- DIN rail mountable (with DIN Mount Kit)

Applications

- Telecommunications Closets
- Data Centers
- Customer Premise
- Local Area Networks
- Wide Area Networks
- Central Offices
- Hub Sites
- Cabinets
- Remote Terminals
- Distributed Antenna Systems (DAS)

LGX is a registered trademark of Furukawa Electric North America, Inc.

Poli-MOD® Patch and Splice Module

Ordering Information

Example: PM-L-12-ASC-0-S-01

PM	L	12	ASC	0	S	01

Configuration
- E = Empty (Splicing Only)
- H = Half Loaded (Adapter Plate only)
- L = Loaded (Adapter Plate & Pigtails)
- D = DAS Poli-MOD[1]

Fiber/Connector Count
- 06 = 6 Fibers/Connectors
- 12 = 12 Fibers/Connectors
- 24 = 24 Fibers/Connectors[2]
- XX = Empty

Connector Type[3]
- ASC = Angle-Polished SC
- USC = Ultra-Polished SC
- PSC = Multimode SC
- ALC = Angle-Polished LC
- ULC = Ultra-Polished LC
- PLC = Multimode LC
- UST = Ultra-Polished ST
- PST = Multimode ST
- AFC = Angle-Polished FC
- UFC = Ultra-Polished FC
- PFC = Multimode FC
- XXX = Empty

Fiber Type
- 0 = Single-mode (G.657.A1 BIF)
- 1 = 62.5 µm (OM1)
- 2 = 50 µm (OM2)
- 3 = 50 µm (OM3)
- 4 = 50 µm (OM4)
- X = Empty

Fiber Arrangement
- S = Single/Standard
- R = Ribbon
- 3 = 3 mm, 3 meter DAS
- X = No Fiber (Half Loaded or Empty)

Packaging
- 01 = 1 Poli-MOD per box*
- 06 = 6 Poli-MODs per box
- 12 = 12 Poli-MODs per box

1. DAS Poli-MOD requires specialty packaging and is packaged as "1 Poli-MOD per box" ONLY.
2. 24 Fibers/Connectors are only available in a LC Duplex configuration.
3. Angle and Ultra-Polished connector types are only available with single-mode fiber configurations.

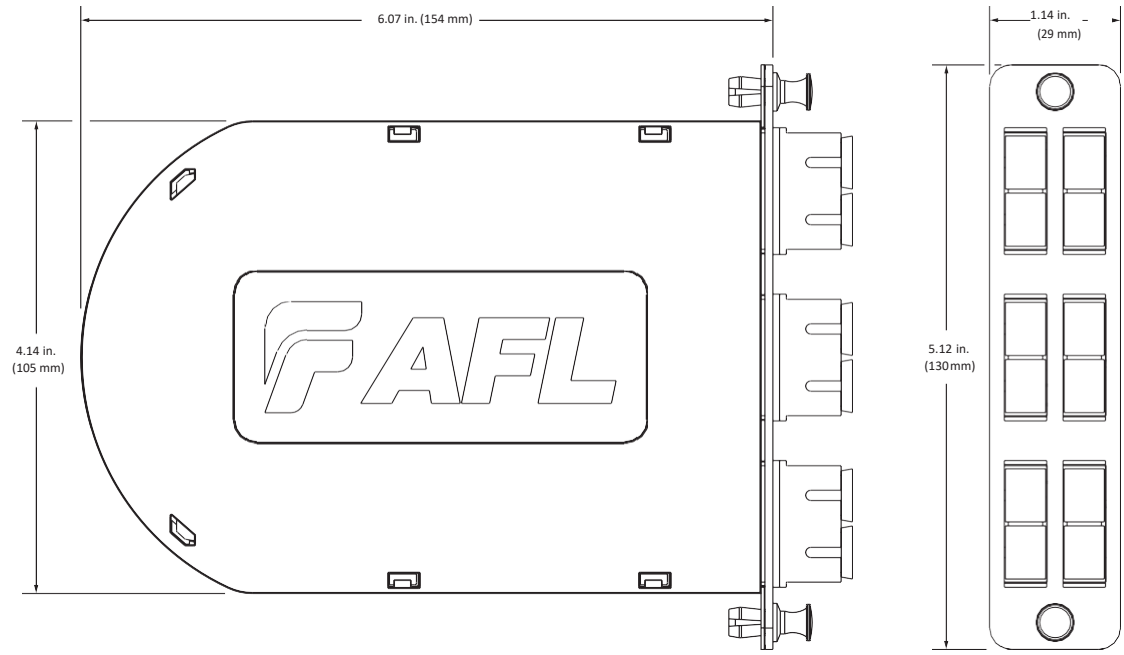
Connector Color Codes

CONNECTOR	COLOR
APC (Angled Polish Connector)	Green
UPC (Ultra Polish Connector)	Blue
PC-OM1	Beige
PC-OM2	Black
PC-OM3 / PC-OM4	Aqua

Poli-MOD Kits/Accessories

DESCRIPTION	AFL NO.
Poli-MOD Cable Mounting Clip Kit	FM003053
Poli-MOD Spiral Wrap Kit	FM003280
Fusion Splice Sleeve, FP-03, 40 mm	S000206
Adapter Bracket for Mounting Single Poli-MOD, angled	FM000948-B
Adapter Bracket for Mounting Single Poli-MOD, flat	FM003589-B
Corning CCH and PCH 145 mm Adapter Bracket	FM001636
DIN Mount Kit, LGX® 118	FM003394

Dimensions

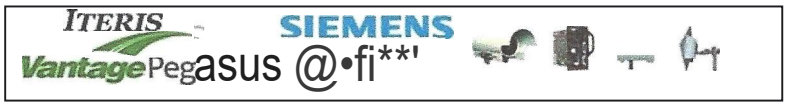


BID ITEM 0003

JOHN DRAKE
1700 Carnegie Ave. Suite 100
Santa Ana, CA 92705-5551
Phone: (512)592-9567
email: jgd@iteris.com, web site: www.iteris.com

EQUIPMENT QUOTE
Quote #: 032917-5-JGD

Ed Kupférer ekupferer@ci.pearland.lx.us
Pearland, City of
255S Hillhonse Rd,
Pearfand, TX 77581



Agency:
Project Name: COMM CABINET

March 29, 2017

ITEM #	DESCRIPTION	NOTES	QTY	
ITEM	COMM CABINET WITH POWER PANEL, SURGE SUPPRESSION AND 4 OUTLET POWER STRIP		IS	[redacted]
EL762TX11	BBS CABINET SHELL		15	
AAD10669-001	TXDOT BBS POWER PANEL		15	
100102001	FAN&THERMO KIT NEMA		15	
4-OUTLET BOX	4 OUTLET POWER STRIP		15	

Fax or email Purchase Orders to: Marilyn Holden, (949/ 270-9441, mdh@iterir.com, pleare *include* **quote number on ye purchase order**

Quote Terms: Net 30 days, subject to credit approval and Iteris Standard Terms & Conditions unless negotiated in writi Iteris, Inc. prior to purchase.

Prices are valid for 30 days from the date of quote unless extended in writing.

FOB Oestination, freight included, does not include insurance. Equipment from this quote may only be installed in the S Texas.

This quotation and any resulting order are subject to iteris' Roadway Sensor Products Standard Terms and Conditions o attached hereto or available at http://www.iteris.com/RS-Std-TC.pdf, which are incorporated herein by this reference.

SUBTOTAL [redacted]

0.00%

[redacted]

Xpress Fiber Management® (XFM®) 4RU Patch Panel

The Xpress Fiber Management (XFM) 4RU patch panel is a rack mountable interconnect point specifically designed to manage dense fiber applications. Based on the LGX® intermateability platform, the panel is fully compatible with AFL's XFM Optical Cassette, Poli-MOD® and WDM solutions, offering enhanced management of densities up to 288F using MTP/MPO, single fiber, or patch and splice methodologies. Routing rings on the top and bottom of the front panel provide enhanced cable routing allowing cable assemblies to exit comfortably. This panel can be provisioned with a key lock at the time of order for secure environments.

Features

- Aluminum construction
- Textured black powder coat finish
- Universal WECO/TIA 19"/23" rack compatibility
- (12) LGX 118 adapter plate / module mounting positions
- Mounting depth adjustable from flush to 8" in 1" increments

Applications

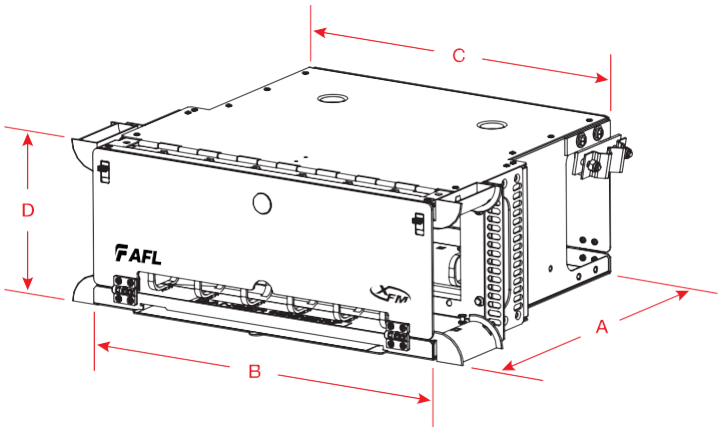
- Data Centers
- Enterprise Networks
- Telecommunications Closets
- Central Offices / Headends

Specifications

DEPTH (A) IN INCHES	FRONT WIDTH (B) IN INCHES	REAR WIDTH (C) IN INCHES	HEIGHT (D) IN INCHES	RACK UNITS	CAPACITY	UNLOADED WEIGHT
15.5	17	15	7	4	(12) LGX 118	9 lbs.

Ordering Information

DESCRIPTION	MODEL NO.	AFL NO.
Xpress Fiber Management 4U Patch Panel, Black, Empty	XFM-4U-B-0	FM001090-B
Xpress Fiber Management 4U Patch Panel, Black, Empty, Key Lock	XFM-4U-B-K	FM001218-B



Made in USA

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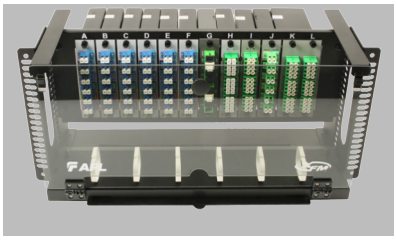
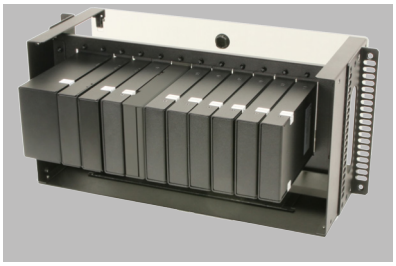




Xpress Fiber Management® (XFM®) 5RU Shelf

The Xpress Fiber Management (XFM) 5RU Shelf is a rack-mountable interconnect panel specifically designed to manage fibers in Wavelength Division Multiplexing (WDM) applications or in situations where fiber entry will occur only at the front entrance of the panel. Based on the LGX® intermateability platform, the panel is fully compatible with AFL's WDM, XFM® Optical Cassette and Poli-MOD® solutions. Routing rings on the bottom of the front panel allow cable assemblies to exit comfortably, while the back of the panel is left open to reduce size and weight.

The XFM Shelf can be conveniently mounted at three depths within the rack which includes a flush-mount option. The XFM Shelf also features a clear, removable front door and a pull-out cable designator card.

Features

- Aluminum construction
- Textured black powder coat finish
- Universal WECO/TIA 19"/23" rack compatibility
- (12) LGX 118 module mounting positions

Applications

- Central Offices / Headends
- Data Centers
- Wavelength Division Multiplexing

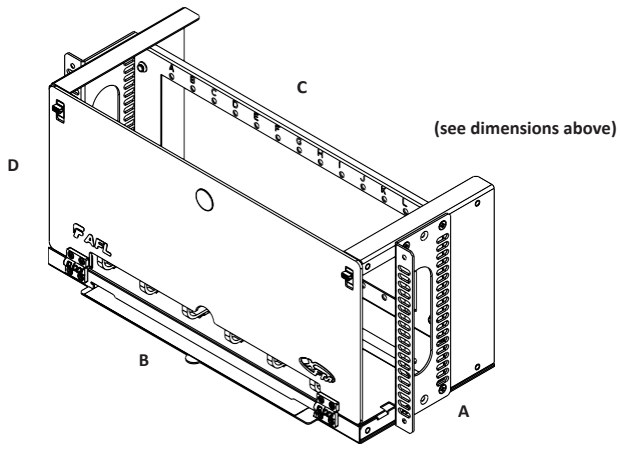
Specifications

DEPTH (A) IN INCHES*	FRONT WIDTH (B) IN INCHES	REAR WIDTH (C) IN INCHES	HEIGHT (D) IN INCHES	RACK UNITS	CAPACITY	UNLOADED WEIGHT
7.5	17	17	8.75	5	(12) LGX 118	4 lbs.

*Does not include installed modules

Ordering Information

DESCRIPTION	AFL NO.
Xpress Fiber Management 5RU Patch Panel, Shelf, Black	FM003626



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WME01

Wall Mount Interconnect Enclosure (WME) with One LGX® Mounting Position

AFL's wall mount interconnect enclosure (WME01) provides a convenient convergence point for interconnecting and/or splicing in wall mount applications. Provisioned for one LGX-compatible adapter plate or optical module, the enclosure features a well-engineered solution for fiber and cable management on both the top and bottom openings of the enclosure. Robust steel construction ensures the highest level of protection for sensitive components while integrated roll-formed hinges eliminate possible fiber pinch points. The WME01 features a front access door which is lockable with a common pad-lock or tube-style keyed lock.

WME01 rear mounting clip for DIN rail

Features

- Fits comfortably into new and existing interconnect, cross-connect and co-location environments
- U-shaped cable entry eliminates the need to feed preconnectorized cables through an inconvenient access port
- Modular design fully compatible with Poli-MOD® products and XFM® optical cassettes
- Locking option for flexibility and security
- Available empty, with adapters, or with adapters, splice chip and pigtails pre-installed
- LGX 118 compatible
- Optional DIN rail mounting kit (sold separately)
- All major connector types are supported

Applications

- Co-Location sites
- Customer premise
- Hub/OTN sites
- Telecommunication closets
- Campus/enterprise environments

WME01 with DIN rail mounting kit

Specifications

- Solid steel construction
- Powder coat black textured finish
- Top or bottom cable entry with dust resistant grommets
- Single-hasp locking/security system
- 12 to 24 fiber patch and splice density
- One LGX mounting position
- Physical dimensions: 5.6"H x 7"W x 1.5"D
- Empty version weight: 2.0 lbs.

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Wall Mount Interconnect Enclosure (WME) with One LGX® Mounting Position

Ordering Information

EMPTY	
DESCRIPTION	AFL NO.
WME01 Empty	WME01E

HALF LOADED: WME WITH ADAPTER PLATES AND ADAPTERS ONLY							
CONN. TYPE	FIBER CT.	AFL NO.					
		UPC SM (BLUE)	APC SM (GREEN)	PC MM 62.5 (BEIGE)	PC MM 50 (BLACK)	PC MM OM3 (AQUA)	PC MM OM4 (AQUA)
SC	6	WME01AS-USCSM-006000	WME01AS-ASCSM-006000	WME01AS-PSCM6-006000	WME01AS-PSCM5-006000	WME01AS-PSCML-006000	WME01AS-PSCMC-006000
	12	WME01AS-USCSM-012000	WME01AS-ASCSM-012000	WME01AS-PSCM6-012000	WME01AS-PSCM5-012000	WME01AS-PSCML-012000	WME01AS-PSCMC-012000
LC	6	WME01AS-UDLSM-006000	WME01AS-ADLSM-006000	WME01AS-PDLM6-006000	WME01AS-PDLM5-006000	WME01AS-PDLML-006000	WME01AS-PDLMC-006000
	12	WME01AS-UDLSM-012000	WME01AS-ADLSM-012000	WME01AS-PDLM6-012000	WME01AS-PDLM5-012000	WME01AS-PDLML-012000	WME01AS-PDLMC-012000
	24	WME01AH-UDLSM-024000	WME01AH-ADLSM-024000	WME01AH-PDLM6-024000	WME01AH-PDLM5-024000	WME01AH-PDLML-024000	WME01AH-PDLMC-024000
ST	6	WME01AS-USTSM-006000	—	WME01AS-PSTM6-006000	WME01AS-PSTM5-006000	WME01AS-PSTML-006000	WME01AS-PSTMC-006000
	12	WME01AS-USTSM-012000	—	WME01AS-PSTM6-012000	WME01AS-PSTM5-012000	WME01AS-PSTML-012000	WME01AS-PSTMC-012000
FC	6	WME01AS-UFCSM-006000	WME01AS-AFCSM-006000	WME01AS-PFCM6-006000	WME01AS-PFCM5-006000	WME01AS-PFCML-006000	WME01AS-PFCMC-006000
	12	WME01AS-UFCSM-012000	WME01AS-AFCSM-012000	WME01AS-PFCM6-012000	WME01AS-PFCM5-012000	WME01AS-PFCML-012000	WME01AS-PFCMC-012000

LOADED: WME WITH ADAPTER PLATES/ADAPTERS/SPLICE CHIP/PIGTAIL (900 µm TIGHT BUFFERED FIBERS 3 METERS IN LENGTH)							
CONN. TYPE	FIBER CT.	AFL NO.					
		UPC SM (BLUE)	APC SM (GREEN)	PC MM 62.5 (BEIGE)	PC MM 50 (BLACK)	PC MM OM3 (AQUA)	PC MM OM4 (AQUA)
SC	6	WME01FS-USCSM-0061C0	WME01FS-ASCSM-0061C0	WME01FS-PSCM6-0061C0	WME01FS-PSCM5-0061C0	WME01FS-PSCML-0061C0	WME01FS-PSCMC-0061C0
	12	WME01FS-USCSM-0121C0	WME01FS-ASCSM-0121C0	WME01FS-PSCM6-0121C0	WME01FS-PSCM5-0121C0	WME01FS-PSCML-0121C0	WME01FS-PSCMC-0121C0
LC	6	WME01FS-UDLSM-0061C0	WME01FS-ADLSM-0061C0	WME01FS-PDLM6-0061C0	WME01FS-PDLM5-0061C0	WME01FS-PDLML-0061C0	WME01FS-PDLMC-0061C0
	12	WME01FS-UDLSM-0121C0	WME01FS-ADLSM-0121C0	WME01FS-PDLM6-0121C0	WME01FS-PDLM5-0121C0	WME01FS-PDLML-0121C0	WME01FS-PDLMC-0121C0
	24	WME01FH-UDLSM-0241C0	WME01FH-ADLSM-0241C0	WME01FH-PDLM6-0241C0	WME01FH-PDLM5-0241C0	WME01FH-PDLML-0241C0	WME01FH-PDLMC-0241C0
ST	6	WME01FS-USTSM-0061C0	—	WME01FS-PSTM6-0061C0	WME01FS-PSTM5-0061C0	WME01FS-PSTML-0061C0	WME01FS-PSTMC-0061C0
	12	WME01FS-USTSM-0121C0	—	WME01FS-PSTM6-0121C0	WME01FS-PSTM5-0121C0	WME01FS-PSTML-0121C0	WME01FS-PSTMC-0121C0
FC	6	WME01FS-UFCSM-0061C0	WME01FS-AFCSM-0061C0	WME01FS-PFCM6-0061C0	WME01FS-PFCM5-0061C0	WME01FS-PFCML-0061C0	WME01FS-PFCMC-0061C0
	12	WME01FS-UFCSM-0121C0	WME01FS-AFCSM-0121C0	WME01FS-PFCM6-0121C0	WME01FS-PFCM5-0121C0	WME01FS-PFCML-0121C0	WME01FS-PFCMC-0121C0

ACCESSORIES	
DESCRIPTION	AFL NO.
DIN Mount Kit, LGX® 118 (Nylon DIN Clips and Screws)	FM003388

Connector/Adapter Key

TYPE	DESCRIPTION
ASC	Angle Polish SC (ZR) sleeve-SM
ASF	Angle Polish SC Duplex (ZR) sleeve-SM
PSC	Physical Polish SC (PB) sleeve-MM
PSF	Physical Polish SC Duplex (PB) sleeve-MM
USC	Ultra Polish SC with (ZR) sleeve-SM
USF	Ultra Polish SC Duplex (ZR) sleeve-SM

TYPE	DESCRIPTION
PST	Physical Polish ST (PB) sleeve-MM
UST	Ultra Polish ST (ZR) sleeve-SM
AFC	Angle Polish FC (ZR) sleeve-SM
PFC	Physical Polish FC (PB) sleeve-MM
UFC	Ultra Polish FC (ZR) sleeve-SM

TYPE	DESCRIPTION
ADL	Angle Polish LC Duplex (ZR) sleeve-SM
PDL	Physical Polish LC Duplex (PB) sleeve-MM
PLC	Physical Polish LC (PB) sleeve-MM
UDL	Ultra Polish LC Duplex (ZR) sleeve-SM
ULC	Ultra Polish LC (ZR) sleeve-SM

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Technical Specification Supplement
Conduit

1. DESCRIPTION

Furnish and install conduit.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 400, “Excavation and Backfill for Structures”
- Item 476, “Jacking, Boring, or Tunneling Pipe or Box”

When specified on the plans, provide:

- rigid metal conduit (RMC);
- intermediate metal conduit (IMC);
- electrical metallic tubing (EMT);
- polyvinyl chloride (PVC) conduit;
- high density polyethylene (HDPE) conduit;
- liquid tight flexible metal conduit (LFMC); or
- liquid tight flexible nonmetallic conduit (LFNC).

Provide conduit
that comply with the details shown on the plans and the NEC. Fabricate fittings such as junction boxes and expansion joints from a material similar to the connecting conduit, unless otherwise shown on the plans. Use watertight fittings. Do not use set screw and pressure-cast fittings. Steel compression fittings are permissible. When using HDPE conduit, provide fittings that are UL-listed as electrical conduit connectors or thermally fused using an electrically heated wound wire resistance welding method.

Use red 3-in. 4-mil polyethylene underground warning tape that continuously states, “Caution Buried Electrical Line Below.”

3. CONSTRUCTION

Perform work in accordance with the details shown on the plans and the requirements of this Item.

Use established industry and utility safety practices when installing conduit located near underground utilities. Consult with the appropriate utility company before beginning work.

Install conduit a minimum of 18 in. deep below finished grade unless otherwise shown on the plans. Meet the requirements of the NEC when installing conduit. Secure and support conduit placed for concrete encasement in such a manner that the alignment will not be disturbed during placement of the concrete. Cap ends of conduit and close box openings before concrete is placed.

Ream conduit to remove burrs and sharp edges. Use a standard conduit cutting die with a 3/4-in. taper per foot when conduit is threaded in the field. Fasten conduit placed on structures with conduit straps or hangers as shown on the plans or as directed. Fasten conduit within 3 ft. of each box or fitting and at other locations shown on the plans or as directed. Use metal conduit clamps that are galvanized malleable or stainless steel unless otherwise shown on the plans. Use 2-hole type clamps for 2-in. diameter or larger conduit.

Fit PVC and HDPE conduit terminations with bushings or bell ends. Fit metal conduit terminations with a grounding type bushing, except conduit used for duct cable casing that does not terminate in a ground box and is not exposed at any point. Conduit terminating in threaded bossed fittings does not need a bushing. Before installation of conductors or final acceptance, pull a properly sized mandrel or piston through the conduit to ensure that it is free from obstruction. Cap or plug empty conduit placed for future use.

Perform trench excavation and backfilling as shown on the plans or as directed, and in accordance with Specification 2317, “Excavation and Backfill for Structures.” Excavation and backfilling will be subsidiary to the installation of the conduit.

Jack and bore as shown on the plans or as directed, and in accordance with Item 476, “Jacking, Boring, or Tunneling Pipe or Box.”

Place warning tape approximately 10 in. above trenched conduit. Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Mark conduit locations as directed.

4. MEASUREMENT

This Item will be measured by the foot of conduit.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Conduit” of the type and size specified and the installation method specified as applicable. This price is full compensation for furnishing and installing conduit; hanging, strapping, jacking, boring, tunneling, trenching, and furnishing and placing backfill; encasing in steel or concrete; replacing pavement structure, sod, riprap, curbs, or other surface; marking location of conduit (when required); furnishing and installing fittings, junction boxes, and expansion joints; and materials, equipment, labor, tools, and incidentals.

Flexible conduit will not be paid for directly but will be subsidiary to pertinent Items. Unless otherwise shown on the plans, no payment will be allowed under this Item for conduit used on electrical services or in foundations.

Ground Boxes

1. DESCRIPTION

- **Installation**. Construct, furnish, and install ground boxes complete with lids.
- **Removal**. Remove existing ground boxes.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following items:

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 432, “Riprap”
- Item 440, “Reinforcement for Concrete”
- Item 618, “Conduit”
- Item 620, “Electrical Conductors”

Provide fabricated precast polymer concrete ground boxes in accordance with DMS-11070, “Ground Boxes.”

Provide other precast or cast-in-place ground boxes that comply with the details shown on the plans.

3. CONSTRUCTION

Perform work in accordance with the details shown on the plans and the requirements of this Item.

Use established industry and utility safety practices when installing or removing ground boxes located near underground utilities. Consult with the appropriate utility company before beginning work.

3.1. **Installation**. Fabricate and install ground boxes in accordance with the details, dimensions, and requirements shown on the plans. Install ground box to approved line and grade.

Construct precast and cast-in-place concrete ground boxes in accordance with Item 420, “Concrete Substructures,” and Item 440, “Reinforcement for Concrete.”

Construct concrete aprons as shown on the plans and in accordance with Item 432, “Riprap,” and Item 440, “Reinforcement for Concrete.”

3.2. **Removal**. Remove existing ground boxes and concrete aprons to at least 6 in. below the conduit level. Uncover conduit to a sufficient distance so that 90 degree bends can be removed and conduit reconnected. Clean the conduit in accordance with Item 618, “Conduit.” Replace conduit within 5 ft. of the ground box. Remove old conductors and install new conductors as shown on the plans. Backfill area with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT

This Item will be measured by each ground box installed complete in place or each ground box removed.

- Operates over 0 to 19 dB path attenuation
- Minimum of 4K MAC addresses
- Minimum of 2 MB buffer memory
- MAC-based trunking
- Port Mirroring

D. Protocols Supported. Provide a Field Ethernet Switch that supports the following protocols:

- IP Multicast Filtering through Internet Group Management (IGMP)v3 Snooping
- Multiprotocol Label Switching (MPLS)
- Common Industrial Protocol (CIP)
- Trivial File Transfer Protocol (TFTP) remote firmware upgrades

E. Standards. Provide a Field Ethernet Switch that adheres to the following standards:

- Institute of Electrical and Electronic Engineers (IEEE) 802.1x support
- IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)
- IEEE 802.3 10BASE-T specification
- Institute of Electrical and Electronic Engineers (IEEE) 802.3 support
- IEEE 802.3u 100BASE-TX Specification
- IEEE 802.3x Flow Control
- IEEE 802.1Q Virtual Local Area Network (VLAN) Tagging
- IEEE 802.1D Spanning Tree Algorithm

F. Management. Provide a Field Ethernet Switch that provides the following management capabilities:

- Hyper Text Transport Protocol (HTTP)/Web Browser device configuration interface
- Security Access Control Lists (ACLs)
- 128 MB DRAM
- 64 MB Compact Flash Memory
- Configurable up to 8000 MAC addresses
- Configurable up to 255 IGMP groups
- QoS classifies and prioritizes data
- Virtual Lans (VLAN)
- Per-port broadcast, multicast, and unicast storm control preventing faulty end stations from degrading overall system performance.
- Telnet device configuration interface
- Simple Network Management Protocol (SNMP) version 2 device status, diagnostic, and alarm monitoring and remote configuration
  - Remote Monitoring (RMON) network monitoring
  - Request for Comments (RFC)-1213-compliant Management Information Base (MIB) files
  - Standard and device specific MIB2 files

G. **Regulatory Approvals.** Provide a Field Ethernet Switch that has been certified to the following regulatory standards:

- Product Safety: Underwriters Laboratories (UL) Standard 1950 or 60950
- Electromagnetic Emissions: Federal Communications Commission (FCC) Part 15, Class A
- National Electrical Manufacturers Association (NEMA) TS-2

H. **Dimensions.** Provide a Field Ethernet Switch with dimensions that do not exceed the following maximums:

- Height: 5.8 in.
- Width: 6.0 in.
- Depth: 4.4 in.
- Weight: 4.4 lb.

I. **Operating Power.** Provide a Field Ethernet Switch that is designed to operate with the following power requirements:

- 18-60VDC
- 0.05 KVA

J. **Environmental.** Provide a Field Ethernet Switch that is designed to operate in the following environmental conditions:

- -40º to 167ºF (-40ºC to 75ºC) operating temperature range
- 13 to 185ºF (-25ºC to 85ºC) storage temperature range
- 10% to 95% relative humidity (non-condensing)

3. **Construction.**

A. **General.** Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

B. **Electronic Components.** Provide electronic components in accordance with the Special Specification, “Electronic Components.”

C. **Mechanical Components.** Provide external screws, nuts and locking washers that are stainless steel. Do not use self-tapping screws.

Provide parts made of corrosion resistant materials, such as plastic, stainless steel, anodized aluminum, or brass.

Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

4. **Documentation Requirements.** Provide documentation in accordance with Articles 4 and 5, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

5. **Testing Requirements.** Perform testing in accordance with Article 2, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

6. **Warranty.** Provide a warranty in accordance with Article 7, Special Specification “Testing, Training, Documentation, Final Acceptance andWarranty.”

7. **Experience Requirements.** Only employ personnel involved in the installation and testing of the “Field Ethernet Switch” that meet the following requirements:

   - Two years experience in the installation and testing of Ethernet Switches.

   - Two installed systems where Ethernet Switches, as described within these specifications, are installed and the systems have been in continuously satisfactory operation for at least one year. Submit photographs or other supporting documents as proof, and the names, addresses, and telephone numbers of the operating personnel who can be contacted regarding the systems.

   - One system with Ethernet Switches (which may be one of the two in the preceding paragraph) for which the Contractor can arrange for demonstration to the Engineer or the Engineer’s representative.

8. **Training.** Perform training in accordance with Article 3, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

9. **Measurement.** This item will be measured as each unit furnished, installed, and tested.

10. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Field Ethernet Switch” of the type specified. This price is full compensation for equipment, cables and connectors; documentation and testing; labor, tools, materials, warranty, training, and incidentals.

Technical Specification Supplement

Intelligent Transportation System (ITS) Fiber Optic Cable

1. DESCRIPTION

Furnish, install, relocate and remove Intelligent Transportation System (ITS) fiber optic cable, fiber patch panels and splice enclosures as shown on the plans.

2. MATERIALS

2.1. **General Requirements.** Provide, assemble, fabricate and install materials that are new, corrosion resistant, and in accordance with the details shown on the plans and in these Specifications.

Furnish, install, splice, and test all new fiber optic cable. Provide all splicing kits, fiber optic cable caps, connectors, moisture or water sealants, terminators, splice trays, fiber optic jumpers, pig tails, fiber patch panels, fiber interconnect housing, and accessories necessary to complete the fiber optic network. Provide all equipment necessary for installation, splicing, and testing.

2.2. **Cable Requirements.** Furnish all-dielectric, dry-filled, gel-free, loose tube fiber optic cable, with low water peak, suitable for underground conduit environments or aerial applications.

Furnish self-supporting, all-dielectric, dry-filled, gel-free, loose tube fiber optic cable, with low water peak suitable for aerial applications when not lashing to strand cable.

All fiber optic cable furnished must have a design life of 20 yr. when installed to the manufacturer's specifications.

Splice fiber optic cables in ground boxes, field cabinets, or buildings. Terminate fiber optic cables in field cabinets and buildings that comply with the details shown on the plans and in this Specification.

Provide all fiber optic cable from the same manufacturer and the manufacturer is International Organization for Standardization (ISO) 9001 certified. Ensure the cables meet or exceed United States Department of Agriculture Rural Utilities Service (RUS) CFR 1755.900, American National Standards Institute/Insulated Cable Engineers Association (ANSI/ICEA) S-87-640, and Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA)-492-CAAB standard.

2.3. **Optical Requirements**.

2.3.1. **Optical Fiber.** Provide ITU G.652 single mode fiber optic cable with a core diameter of 8.3 ± 0.7 microns and a cladding diameter of 125 ± 0.7 microns. Provide optical fiber made of glass consisting of a silica core surrounded by concentric silica cladding, free of imperfections and inclusions.

2.3.2. **Core/Clad Concentricity.** Provide an offset between the center of the core and cladding less than
0.5 microns.

2.3.3. **Mode Field Diameter.** Provide single mode fiber optic cable with the effective area or Mode Field Diameter of the fiber must be 9.2 ± 0.4 µm at 1310 nm and 10.5 ± 1.0 µm at 1550 nm.

2.3.4. **Primary Coating.** Provide fiber with a coating diameter of 250 ±15 microns.

2.3.5. **Attenuation.** Provide single mode fiber optic cable with nominal attenuation of 0.35 dB/km maximum at a wavelength of 1310 nm and nominal attenuation of 0.25 dB/km maximum at a wavelength of 1550 nm.

Attenuation at water peak must be less than 0.35 dB/km at 1383 nm.

2.3.6. **Bandwidth and Dispersion.** Provide single mode fiber optic cable with a maximum dispersion of:

- 3.2 ps/nm-km at a wavelength of 1310 nm, and
- 18 ps/nm-km at a wavelength of 1550 nm.

Zero dispersion wavelength must be between 1300 nm and 1324 nm and the zero dispersion slope at the zero dispersion wavelength must be less than 0.092 ps/(nm^2 • km).

The cutoff wavelength must be less than 1260 nm for single mode fibers specified to operate at 1310 nm. The cutoff wavelength must be less than 1480 for single mode fibers specified to operate only at 1550 nm or higher.

The macrobend attenuation per 100 turns must not exceed 0.05 dB at 1310 nm and 1550 nm.

2.3.7. **Mechanical Requirements(Tensile Strength).** Provide a cable withstanding a pulling tension of 600 lbf without increasing attenuation by more than 0.8 dB/mi when installing in underground conduit systems in accordance with EIA-455-33A. Conduct an impact test in accordance with TIA/EIA-455-25C (FOTP-25) and a compression load test in accordance with TIA/EIA-455-41A (FOTP-41).

For all-dielectric self-supporting cable (ADSS) and other self-supporting cables, meet tensile strength requirements in accordance with Section 25, Loading of Grades B and C, of National Electric Safety Code (NESC), for the maximum span and sag information as shown in the plans for aerial construction.

2.3.8. **Bend Radius.** Provide a cable withstanding a minimum bending radius of 10 times its outer diameter during operation, and 20 times its outer diameter during installation, removal and reinstallation without changing optical fiber characteristics. Test the cable in accordance with EIA-455-33A.

2.3.9. **Buffering.** Use a buffering tube or jacket with an outer diameter of 1.0 to 3.0 mm containing 12 individual fiber strands. The fibers must not adhere to the inside of the buffer tube.

2.3.10. **Color Coding.** Provide fiber and buffer tubes with a color coating applied to it by the manufacturer. Coating must not affect the optical characteristics of the fiber. Provide color configuration in accordance with TIA/EIA- 598 as follows:

- 1. Blue
- 2. Orange
- 3. Green
- 4. Brown
- 5. Slate
- 6. White
- 7. Red
- 8. Black
- 9. Yellow
- 10. Violet
- 11. Rose
- 12. Aqua

3. EQUIPMENT

3.1. **Cable Type.** Provide cables with a reverse oscillation or planetary stranding structure.

Jacket construction and group configuration should separate at splice points to cut and splice 1 set of fibers while the others remain continuous. All cable jackets must have a ripcord to aid in the removal of the outer jacket. Submit cable designs for approval.

Strand loose buffer tubes around a dielectric central anti-buckling strength member. Provide dielectric aramid or fiber glass strength members with specified strength for the cable. Provide cable with a water-blocking material, which is non-hygroscopic, non-nutritive to fungus, non-conductive, non-toxic, and homogeneous.
The water blocking material must comply with TIA/EIA-455-81B and 455-82B as well as TIA/EIA-455-98.

Ensure a polyethylene inner jacket is applied over the cable core, and that the entire cable is enclosed with a polyethylene outer jacket. Ensure the outer jacket contains black carbon to provide UV protection for the cable. Ensure each cable is marked with the manufacturer's name, the date of manufacture (month/year), the fiber count (example 48F SM), and sequential length markings at maximum 2 ft. increments, measured in U.S. units.

For aerial installation, provide standard fiber optic cable lashed to steel messenger cable or ADSS in accordance with the Institute of Electrical and Electronics Engineers (IEEE) 1222 Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines, or most current version. Provide ADSS cable in accordance with the maximum span distance, weather load rating, and allowable sag as shown on the plans. "Figure 8" self-supporting cable with integrated messenger cable within the outer jacket for aerial installation is acceptable.

3.1.1. **Cable Size.** Furnish cables with a maximum diameter not exceeding 19 mm.

3.1.2. **Environmental Requirements.** Provide cable that functions in a temperature range from -40°F to 158°F.

3.2. Fiber Optic Accessories.

3.2.1. **Splice Enclosures.** Furnish and install 1 of 3 types of underground splice enclosures at locations shown on the plans to accommodate the cables being spliced at that point. The types are as follows:

- Type 1: 4 cable entry ports total – 2 ports to accommodate backbone fiber of up to 144 fibers and 2 ports for drop cables of up to 48 fibers,
- Type 2: 6 cable entry ports total – 4 to accommodate backbone or arterial cables of up to 144 fibers and 2 ports for drop cables of up to 48 fibers, and
- Type 3: 8 cable entry ports total – 4 to accommodate backbone or arterial cables of up to 144 fibers and 4 ports for drop cables of up to 48 fibers.

Provide the end cap of the canister splice closure with re-enterable quick-seal cable entry ports to accommodate additional branch cables or backbone cables. Provide fiber optic splice enclosures with strain relief, splice organizers, and splice trays from the same manufacturer as the splice enclosure. Select the appropriate splice enclosure type based on the number of splices called for in the plans. Suspend all splice closures off floor of the ground box and secure to cable rack assembly on side wall of ground box.

For end of reel splicing, use a fiber optic splice enclosure sized to accommodate full cable splice in one enclosure. Fiber optic splice enclosure must be of the same manufacturer as other supplied on a project. Splice enclosure and fusion splicing required for end of reel will be incidental to the fiber optic cable.

Comply with the Telcordia Technologies' GR-711-CORE standard and all applicable NEC requirements.

Contain all optical fiber splices within a splice enclosure, providing storage for fiber splices, nonspliced fiber, and buffer tubes. Provide sufficient space inside the enclosure to prevent microbending of buffer tubes when coiled.

Ensure that the splice enclosure maintains the mechanical and environmental integrity of the fiber optic cable, encases the sheath opening in the cable, and organizes and stores optical fiber. Ensure all hinges and latching devices are stainless steel or of a non-corrosive material designed for harsh environments. Ensure that the enclosure is airtight and prevents water intrusion. Ensure that splice enclosures allow re-entry and are hermetically sealed to protect internal components from environmental hazards and foreign material such as moisture, dust, insects, and UV light.

3.2.2. **Field Rack Mount Splice Enclosures.** Provide a 19 in. EIA rack mounted splice enclosure module to hold spliced fibers as shown in the plans inside field equipment cabinets or buildings.

Splice or terminate fibers inside rack mounted fiber optic splice enclosures. Provide an enclosed unit designed to house a minimum of 4 cables, sized to accommodate at a minimum the cables shown on the plans plus future expansion.

Provide splice enclosures containing mounting brackets with a minimum of 4 cable clamps. Install cable according to manufacturer recommendations for the cable distribution panel.

3.2.3. **Fiber Patch Panels.** Provide fiber patch panels that are compatible with the fiber optic cable being terminated and color coded to match the optical fiber color scheme. Coil and protect a maintenance loop of at least 5 ft. of buffer tube inside the rack mount enclosure, patch panel, or splice tray. Allow for future splices in the event of a damaged splice or pigtail.

3.2.3.1. **Cabinet.** Terminate or splice fibers inside the compact and modular fiber patch panel in the cabinet. Provide fiber patch panel for installation inside a 19 in. EIA rack and sized appropriately to accommodate the fiber terminations shown on the plans or as directed by the Engineer. Provide each patch panel housing with pre- assembled compact modular snap-in simplex connector panel modules, each module having a minimum of 6 fiber termination/connection capabilities. Provide modules with a removable cover having 6 pre- connectorized fiber pigtails, interconnection sleeves, and dust caps installed by the manufacturer. Provide a 12 fiber or greater fusion splice tray capability housing, each tray holding 12 fusion splices as shown in the plans. Stack splice trays on a rack to permit access to individual trays without disturbing other trays. Locate splice trays in a rack within a pull-out shelf. Protect the housing with doors capable of pivoting up or

down. Document the function of each terminated/spliced fiber, along with the designation of each connector on labels or charts located either on the inside or outside of the housing door. Provide labels or charts that are UV resistant design for harsh environments and used inside field equipment cabinets. Use permanent marker or method of identification that will withstand harsh environments. Provide each housing with strain relief. Terminate single mode fiber optic cable with SC connectors to the patch panels, unless otherwise shown on the plans.

Install the fiber patch panel as an integral unit as shown on the plans.

3.2.3.2. **Building.** Provide a fiber patch panel with a modular design allowing interchangeability of connector panel module housing and splice housing within the rack, as shown on the plans.

Provide the number of single mode fibers, connector panel module housings, and splice housings for the patch panel unit in the building as shown on the plans.

Provide a fiber patch panel unit, installed at a height less than 7 ft., capable of housing 8 connector panel module housings or 8 splice housings. Protect the housing with doors capable of pivoting up or down and sliding into the unit.

Provide 12 snap-in simplex connector panel modules with each connector panel module housing, each module having 6 fiber termination/connector capabilities. Use a pre-assembled compact modular unit with a removable cover for the snap-in simplex connector panel module having 6 pre-connectorized fiber pigtails, interconnection sleeves, and dust caps installed by the manufacturer. Provide each connector panel module housing with a jumper routing shelf, storing up to 5 ft. (minimum) of cable slack for each termination within the housing. Provide the fiber distribution unit with strain relief.

Provide splice enclosure with 24 fusion splice tray capabilities, each splice tray holding 12 or more fusion splices. Stack splice trays on a rack to permit access to individual trays without disturbing other trays. Locate the rack on a pull-out shelf.

Document the function of each terminated/spliced fiber, along with the designation of each connector on labels or charts located either on the inside or outside of the housing door. Provide labels or charts that are UV resistant design for harsh environments and used inside field equipment cabinets. Use permanent marker or method of identification that will withstand harsh environments. Also provide documentation of the function of each terminated or spliced fiber along with the designation of each connector on charts or

diagrams matching the fiber patch panel configuration and locate inside cabinet document drawer. Provide documentation at the conclusion of fiber terminations and splicing.

Allow terminations only in the fiber interconnect housings placed in the cabinets as shown on the plans or as directed.

3.2.4. **Splice Trays**. Use splice tray and fan-out tubing kit for handling each fiber. Provide a splice tray and 12 fiber fan-out tubing with each housing for use with the 250 microns coated fiber. The fan-out will occur within the splice tray (no splicing of the fiber required). Allow each tube to fan out each fiber for ease of connectorization. Label all fibers in splice tray on a log sheet securing it to the inside or outside of the splice tray. Provide UV resistant log sheet suitable for harsh environments, located inside field cabinets or splice enclosures. Provide fan-out tubing with 3 layers of protection consisting of fluoropolymer inner tube, a dielectric strength member, and a 2.9 mm minimum outer protective PVC orange jacketing.

3.2.5. **Jumpers.** Provide fiber optic jumper cables to cross connect the fiber patch panel to the fiber optic transmission equipment as shown on the plans or as directed. Match the core size, type, and attenuation from the cable to the simplex jumper. Use yellow jumpers and provide strain relief on the connectors. Provide fiber with a 900 micron polymer buffer, Kevlar strength member, and a PVC jacket with a maximum outer jacket of 2.4 mm in diameter.

Provide 5 ft. long jumpers, unless otherwise shown on the plans. On the patch panel end of each jumper, provide an SC connector. On the opposite end of the jumper, provide a connector that is suitable to be connected to the fiber optic transmission equipment selected. When providing jumpers for existing equipment, provide connectors suitable to be connected to patch panels and fiber optic transmission equipment in use. All jumpers must have factory terminated connectors. Field terminations of connectors is prohibited.

3.2.6. **Fiber Optic Cable Storage Device.** Furnish fiber optic cable storage device designed to store slack fiber optic cable by means of looping back from device to device on an aerial run. Furnish storage devices that are non-conductive and resistant to fading when exposed to UV sources and changes in weather. Ensure storage devices have a captive design such that fiber-optic cable will be supported when installed in the aerial rack apparatus and the minimum bending radius will not be violated. Provide stainless steel attachment hardware for securing storage devices to messenger cable and black UV resistant tie-wraps for securing fiber-optic cable to storage device. Provide tie-wraps that do not damage fiber when securing to storage device. Ensure storage devices are stackable so multiple cable configurations are possible. Ensure cable storage devices furnished are compatible with the type of aerial cable furnished and installed. Aerial cable storage devices will be considered incidental to the installation of the fiber optic cable.

4. CONSTRUCTION

Install fiber optic cable in accordance with United States Department of Agriculture Rural Utilities Service CFR 1755.900 specifications for underground and aerial plant construction without changing the optical and mechanical characteristics of the cables.

Utilize available machinery, jacking equipment, cable pulling machinery with appropriate tension monitors, splicing and testing equipment, and other miscellaneous tools to install cable, splice fibers, attach connectors and mount hardware in cabinets employed with the above “Mechanical Requirements.” Do not jerk the cable during installation. Adhere to the maximum pulling tensions of 600 lbf and bending radius of 20 times the cable diameter or as specified by the manufacturer, whichever is greater.

Use installation techniques and fixtures that provide for ease of maintenance and easy access to all components for testing and measurements. Take all precautions necessary to ensure the cable is not damaged during transport, storage, or installation. Protect as necessary the cables to prevent damage if being pulled over or around obstructions along the ground.

Where plans call for removal of existing cable to salvage or reuse elsewhere, take care to prevent damaging the existing cable during removal adhering to all of the requirements for installation that pertain to removal.

4.1. **Packaging, Shipping, and Receiving.** Ensure the completed cable is packaged for shipment on reels. Ensure the cable is wrapped in weather and temperature resistant covering. Ensure both ends of the cable are sealed to prevent the ingress of moisture.

Securely fasten each end of the cable to the reel to prevent the cable from coming loose during transit. Provide 6 ft. of accessible cable length on each end of the cable for testing. Ensure that the complete outer jacket marking is visible on these 6 ft. of cable length. Provide each cable reel with a durable weatherproof label or tag showing the Manufacturer's name, the cable type, the actual length of cable on the reel, the Contractor's name, the contract number, and the reel number. Include a shipping record in a weatherproof envelope showing the above information and also include the date of manufacture, cable characteristics (size, attenuation, bandwidth, etc.), factory test results, cable identification number and any other pertinent information. Ensure that all cable delivered has been manufactured within 6 mo. of the delivery date. Ensure that the minimum hub diameter of the reel is at least 30 times the diameter of the cable. Provide the cable in one continuous length per reel with no factory splices in the fiber. Provide a copy of the transmission loss test results as required by the TIA/EIA-455-61 standard, as well as results from factory tests performed prior to shipping.

4.2. **Installation in Conduit.** Install fiber optic cable in conduits in a method that does not alter the optical properties of the cable. If required, relocate existing cable to allow new fiber optic cable routing in conduits.

When pulling the cable, do not exceed the installation bending radius. Use rollers, wheels, or guides that have radii greater than the bending radius. Use a lubricating compound to minimize friction. Use fuse links and breaks to ensure that the cable tensile strength is not exceeded. Measure the pulling tension with a mechanical device and mechanism to ensure the maximum allowable pulling tension of 600 lbf is not exceeded at any time during installation.

Provide a single 1/C #14 XHHW insulated tracer wire in conduit runs where fiber optic cable is installed. Provide cable that is UL listed solid copper wire with orange color low density polyethylene insulation suitable for conduit installation and with a voltage rating of 600V. When more than one fiber optic cable is installed through a conduit run, only one tracer wire is required. Fuse or join tracer wires used in backbone, arterial, and drop runs, so that you have one continuous tracer wire. Terminate tracer wire at fiber optic test markers or equipment cabinets as identified in the plans for access to conduct a continuity test. Tracer wire will be paid for under Item 620, "Electrical Conductors."

Provide flat pull cord with a minimum tensile strength of 1,250 lb. in each conduit containing fiber optic cable. A traceable pull cord, with a metallic conducting material integral to the pull cord, may be substituted for a 1/C #14 tracer wire only with approval from the Department.

Seal conduit ends with a 2-part urethane after installation of fiber optic cable.

4.3. **Cable Installation between Pull Boxes and Cabinets or Buildings.** Do not break or splice a second fiber optic cable to complete a run when pulling the cable from the nearest ground box to a cabinet or building. Pull sufficient length of cable in the ground box to reach the designated cabinet or building. Pull the cable through the cabinet to coil, splice, or terminate the cable in the cabinet or building. Do not bend the cable beyond its minimum bend radius of 20 times the diameter.

Coil and tie cable inside cabinet, building, or boxes for future splicing or termination as shown in the plans. Cut off and remove the first 10 ft. of pulled or blown fiber stored. This work is incidental to this Item. Coat the open end of the coiled cable with protective coating and provide a dust cap.

4.4. **Aerial Installation.** Use pole attachment hardware and roller guides with safety clips to install aerial run cable. Maintain maximum allowable pulling tension of 600 lb. ft. during the pulling process for aerial run cable by using a mechanical device. Do not allow cable

to contact the ground or other obstructions between poles during installation. Do not use a motorized vehicle to generate cable pulling forces. Use a cable suspension clamp when attaching cable tangent to a pole. Select and place cable blocks and corner blocks so as not to exceed the cable's minimum bending radius. Do not pull cable across cable hangers. Store 100 ft. of fiber- optic cable slack, for future use, on all cable runs that are continuous without splices or where specified on the plans. Store spare fiber optic cable on fiber-optic cable storage racks of the type compatible with the aerial cable furnished. Locate spare cable storage in the middle of spans between termination points. Do not store spare fiber-optic cable over roadways, driveways or railroads.

Install standard cable on timber poles by lashing to steel messenger cable. Provide steel messenger cable in accordance with Item 625, "Zinc Coated Steel Wire Strand." Install all-dielectric self-supporting cable (ADSS) cable on timber poles using clinching clamp with cable hanger. Install aerial run cable in accordance with these specifications and as shown on the plans.

Locate aerial fiber in accordance with the NESC, Section 23, with respect to vertical clearances over the ground, between conductors carried on different supporting structures, and required separation distance of the cable from bridges, buildings, and other structures.

4.5. **Blowing Fiber Installation.** Use either the high-air speed blowing (HASB) method or the piston method. When using the HASB method, ensure that the volume of air passing through the conduit does not exceed 600 cu. ft. per min. or the conduit manufacturer's recommended air volume, whichever is more restrictive. When using the piston method, ensure that the volume of air passing through the conduit does not exceed 300 cu. ft. per min. or the conduit manufacturer's recommended air volume, whichever is more restrictive.

4.6. **Slack Cable**. Pull and store excess cable slack inside ITS ground boxes as shown on the plans. The following are minimum required lengths of slack cable, unless otherwise directed:

- ground boxes (No Splice) - 25 ft.,
- ground boxes (With Splice) - 100 ft.,
- future splice point - 100 ft., and
- cabinets - 25 ft.

Note that the slack is to be equally distributed on either side of the splice enclosure and secured to cable storage racks within the ground boxes.

Provide proper storage of slack cable, both long term and short term. Neatly bind cables to be spliced together from conduit to splice enclosure with tape. Do not over bind by pinching cable or fiber. Ground and bond the armor when installing armored fiber optic cable. Meet NEC and NESC requirements for grounding and bonding when using armored cable.

4.7. **Removal, Relocation and Reinstallation of Fiber Optic Cable.** Remove fiber optic cable from conduit as shown on plans. Use care in removing existing fiber optic cables so as not to damage them. Provide cable removal and reinstallation procedures that meet the minimum bending radius and tensile loading requirements during removal and reinstallation so that optical and mechanical characteristics of the existing cables are not degraded. Use entry guide chutes to guide the cable out of and in to existing or proposed conduit, utilizing lubricating compound where possible to minimize cable-to-conduit friction. Use corner rollers (wheels) with a radius not less than the minimum installation

bending radius of cable. Dispose of removed fiber optic cable unless plans show for it to be re-used (relocated/re-installed) or salvaged and delivered to the Department. See plans for details. Test each optical fiber in the cable for performance and for loss at existing terminations or splices prior to cutting and removal. Retest following removal and following re- installation to ensure the removal and reinstallation has not affected the optical properties of the cable. Any fiber optic cable damaged by the contractor that is to be re-used shall be replaced by the contractor at no cost to the Department with new fiber optic cable meeting the approval of the Engineer. The Engineer reserves the right to reject the fiber based on the test results.

Maintain the integrity of existing cables, conduit, junction boxes and ground boxes contiguous to the section of cables to be removed. Replace or repair any cables, conduit, junction boxes or ground boxes damaged during work at the Contractor's expense. The replacement or repair method must be approved by the Engineer, prior to implementation.

4.8. **Splicing Requirements.** Fusion splice fibers as shown on the plans, in accordance with TIA/EIA-568 and TIA/EIA-758.

Use fusion splicing equipment recommended by the cable manufacturer. Clean, calibrate, and adjust the fusion splicing equipment at the start of each shift. Use splice enclosures, organizers, cable end preparation tools, and procedures compatible with the cable furnished. Employ local injection and detection techniques and auto fusion time control power monitoring to ensure proper alignment during fusion splicing.

When approaching end of shift or end of day, complete all splicing at the location. Package each spliced fiber in a protective sleeve or housing. Re-coat bare fiber with a protective 8 RTV, gel or similar substance, prior to application of the sleeve or housing.

Perform splices with losses no greater than 0.10 dB. Use an Optical Time Domain Reflectometer (OTDR) to test splices in accordance with Section 4.13.1.1. Record splice losses on a tabular form and submit for approval.

4.9. **Termination Requirements.** Provide matching connectors with 900 micron buffer fiber pigtails of sufficient length and splice the corresponding optical fibers in cabinets where the optical fibers are to be connected to terminal equipment. Buffer, strengthen, and protect pre-terminated fiber assemblies (pigtails) with dielectric aramid yarn and outer PVC jacket to reduce mishandling that can damage the fiber or connection. Pigtails must be duplex stranding with a yellow PVC outer jacket. Fiber optic pigtails must be factory terminated with SC connectors, unless otherwise shown on the plans. When providing pigtails for existing equipment, provide connectors suitable to be connected to patch panels and fiber optic transmission equipment in use.

Connectors must meet the TIA/EIA-568 and TIA/EIA-758 standards and be tested in accordance to the Telcordia/Bellcore GR-326-CORE standard. When tested according to TIA/EIA-455-171 (FOTP-171), ensure that the connectors test to an average insertion loss of less than or equal to 0.4 dB and a maximum loss of less than or equal to 0.75 dB for any mated connector. Maintain this loss characteristic for a minimum of 500 disconnections and reconnections with periodic cleanings per EIA-455-21A (FOTP-21). Qualify and accept connectors by the connector-to-connector mating using similar fibers. Ensure that the connector operating range is -40ºF to 167ºF. Provide connectors with a yellow color body or boot.

Test connections at the patch panel and splices made between cables to pigtails with the OTDR to verify acceptable losses.

Remove 5 ft. of unused optical fibers at the ends of the system from the buffer tube(s) and place coiled fibers into a splice tray. Clean the water blocking compound from all optical fibers destined for splice tray usage.

Install cable tags at all splice points identifying key features of each cable such as cable name or origin and destination and fiber count. Ensure tags are self-laminating or water resistant. Print the information onto the tags electronically or write neatly using a permanent marker. Locate tags just prior to entrance into splice enclosure.

4.10. **Mechanical Components.** Provide stainless steel external screws, nuts and locking washers. Do not use self-tapping screws unless approved. Provide corrosion resistant material parts and materials resistant to fungus growth and moisture deterioration.

4.11. **Experience Requirements**.

4.11.1. **Installing Fiber Optic Cable.** The Contractor or designated subcontractor involved in the installation of the fiber optic cable must meet the experience requirements in accordance with the following:

- minimum of 3 yr. of continuous existence offering services in the installation of fiber optic cable through an outdoor conduit system or aerial and terminating in ground boxes, field cabinets or enclosures or buildings, and
- completed a minimum of 3 projects where the personnel pulled a minimum of 5 mi. in length of fiber optic cable through an outdoor conduit system of aerial for each project. The completed fiber optic cable systems must have been in continuous satisfactory operation for a minimum of 1 yr.

4.11.2. **Splicing and Testing of Fiber Optic Cable.** The Contractor or designated subcontractor involved in the splicing and testing of fiber optic cable must meet the experience requirements in accordance with the following:

4.11.2.1. **Minimum Experience**. 3 yr. continuous existence offering services in the fields of fusion splicing and testing of fiber optic cable installed through a conduit system and terminating in ground boxes, field cabinets or enclosures or buildings. Experience must include all of the following:

- termination of a minimum of 48 fibers within a fiber distribution frame,
- OTDR testing and measurement of end to end attenuation of single mode and multimode fibers,
- system troubleshooting and maintenance,
- training of personnel in system maintenance,
- use of water-tight splice enclosures, and
- fusion splicing of fiber optic cable which meet the tolerable decibel (dB) losses within the range of 0.05 dB – 0.10 dB for single mode.

4.11.2.2. **Completed Projects**. A minimum of 3 completed projects where the personnel performed fiber optic cable splicing and terminations, system testing, system troubleshooting and maintenance during the course of the project and provided training on system maintenance. Each project must have consisted of a minimum 5 mi. of fiber optic cable installed, measured by project length not linear feet of fiber installed. The completed fiber optic cable systems must have been in continuous satisfactory operation for a minimum of 1 yr.

4.12. **Documentation Requirements.** Provide a minimum of 2 complete sets of fiber optic equipment submittal literature documenting compliance with the requirements of this Item including operation and maintenance manuals in hard copy format, bound, as well

as an electronic version in Adobe PDF format on a CD/DVD or removable flash drive that includes the following:

- fiber optic cable literature consisting of manufacturer specification and cut sheets,
- fiber optic equipment literature consisting of manufacturer specification and cut sheets for splice enclosures, patch panels, splice trays, jumpers, cable storage devices, and fiber optic labeling devices,
- complete factory performance data documenting conformance with the performance and testing standards referenced in this Item, including pre-installation test results of the cable system,
- installation, splicing, terminating and testing plan and procedures,
- documentation of final terminated or spliced fibers, function, and equipment designation,
- OTDR calibration certificate,
- post-installation, post termination, subsystem, and final end-to-end test results,
- loss budget calculation and documentation,
- complete parts list including names of vendors,
- complete maintenance and trouble-shooting procedures, and
- proof of minimum experience and completed projects.

4.12.1. **Installation Practice**. Submit for approval electronic copy of the Contractors Installation Practices 30 working days prior to installation. Submit installation practices and procedures and a list of installation, splicing and test equipment used. Provide detailed field quality control procedures and corrective action procedures.

4.12.2. **Manufacturer's Certification.** Accompany each reel of fiber optic cable with the manufacturer's test data showing the conformance to the requirements in this Item.

4.12.3. **Test Procedures.** Submit test procedures and data forms for the pre-installation, post-installation, subsystem, final end to end test, and loss budget calculations for approval. Test procedures will require approval before performing tests. Submit 1 copy data forms containing data and quantitative results, as well as an authorized signature. Submit a copy of the OTDR results as a hard copy or electronic copy in PDF format including all OTDR traces and clearly identifying each event (fusion splice, jumper, connector, etc.) with the measured loss identified.

4.13. **Testing.** Perform tests in accordance with testing requirements in this Item, USDA RUS CFR 1755.900, and TIA/EIA-455-61 test specifications. For all tests, provide test forms to be used that compare measured results with threshold values.

4.13.1. **Test Methods**.

4.13.1.1. **Optical Time Domain Reflectometer (OTDR) Tests.** Use the OTDR to measure fiber optic cable for overall attenuation (signal loss dB/km), fiber cable length, and identify fiber optic cable anomalies such as breaks. Perform the following 4 OTDR tests:

- pre-Installation test (Acceptance test),
- post installation test,
- post termination test, and
- final end to end test.

OTDR Settings:

- generate a file name for each OTDR scan. The file name must indicate the location or direction the test was run from, as well as the fiber number being tested,

- set the “A” cursor at the beginning of the fiber trace and set the “B” cursor at the end of the fiber trace. The distance to cursor “B” indicates the length of the fiber cable segment being measured,
- match the index of refraction to the index of the factory report,
- set the loss indicator to dB/km for the acceptance test,
- the reflectance is automatically set internally by the OTDR,
- set the pulse width at a medium range. Change the pulse width to a slow pulse width when an anomaly occurs on the fiber trace so that it can be examined closely,
- set the average at medium speed. Change the average to slow when an anomaly appears on thefiber trace to allow for closer examination of the anomaly, and
- set wavelength at 2 windows for single mode cable: 1310 nm and 1550 nm.

Provide the current OTDR calibration certificate for the device used, showing the unit has been calibrated within the last year. Show all settings on test result fiber scans.

4.13.1.2. **Pre-installation Tests.** Test and record the fiber optic cable at the site storage area prior to installation.

Conduct bi-directional OTDR tests for each fiber strand. Test each optical fiber in the cable from one end with an OTDR compatible with wavelength and fiber type. Check testing for length, point discontinuity, and approximate attenuation. Record each measurement by color, location, and type of fiber measured. Perform a measurement from the opposite end of that fiber in case a measurement cannot be made from one end. Wait for notification if loss per kilometer exceeds manufacturer’s test data by more than 0.5 dB/km or point discontinuity greater than 0.05 dB.

Perform this test within 5 days from receipt of the fiber optic cable. Test overall attenuation (dB/km), total cable length, anomalies, and cable problems. Test cable at both wavelengths (1310 nm and 1550 nm for single mode cable). Verify that the cable markings on the outer jacket are within 1% of the total cable length.

Compare factory test results with test results and return to manufacturer if test results are not identical to factory test results. If identical, document the test results. Deliver documentation for future reference.

4.13.1.3. **Post-installation Tests.** Re-test and re-record each optical fiber in the cable after installation, before termination, for loss characteristics. Test both directions of operations of the fiber.

Immediately perform the post installation test after the fiber optic cable has been installed. Test cable for overall attenuation, cable segment length, and evidence of damage or microbend with the OTDR. Replace any cable segment that is damaged during the test and document test results. Submit test results for approval.

Use the same OTDR settings for Post-Installation Tests as the Pre-Installation Tests.

4.13.1.4. **Post Termination Tests.** Perform the post termination test after the cable is terminated or spliced, including termination of fiber cable to fiber cable or fiber cable to fiber pigtail and fiber cable to patch panels. Check attenuation, fusion or termination point problems, and overall fiber cable segment. Determine if the attenuation and quality of the termination complies with these Specifications; if not, re-terminate the fiber and re-test until the Specification requirements are met. Test the fiber segment for attenuation and anomalies after termination acceptance. Document and submit test results after fiber segment acceptance.

4.13.1.5. **Subsystem Tests.** Perform network subsystem tests after integration to the fiber optic network. Test the capability of the fiber optic cable to transmit video and digital information from node to node. A node is defined as a communication cabinet, hub cabinet, surveillance cabinet, or hub building where network hub switches are located. Complete and submit approved data forms for approval.

Correct and substitute components in the subsystem if the subsystem tests fail and repeat the tests. Components may include: cable, jumper, patch panel module, or connector.

Prepare and submit a report if a component was modified as result of the subsystem test failure. Describe in the report the failure and action taken to remedy the situation.

4.13.1.6. **Final End-to-End Test.** Perform final end to end Test after fiber cable segments of the system are terminated using the OTDR and an optical Power Meter and Light Source (PMLS).

Perform the Part 1 of the final end to end test using OTDR:

- measure the overall fiber cable system length,
- measure the overall system attenuation, and
- check for anomalies.

Perform the Part 2 of the final end to end test using a PMLS:

- measure the absolute power of the fiber optic signal across all links, and
- check for anomalies.

Document and submit results after test acceptance.

4.13.2. **Loss Budget Calculation and Documentation.** Calculate the total loss budget of the system according to the following calculations and compare the actual loss in each segment of the system to the calculated budget. Submit the results for each section of fiber optic cable in tabular format reporting if the total loss is within the limits of these Specifications by noting “pass” or “fail” for each segment of fiber. A segment of fiber is defined as one that terminates at each end. Use the following calculations to determine the loss budget for each segment:

- splice loss budget = number of splices x 0.1 dB/splice,
- connector loss budget = number of connectors x 0.75 dB/connector,
- length loss budget = length of fiber optic cable (measured by OTDR) x 0.35 dB/km for 1310 nm wavelength or 0.25 dB/km for 1550 nm wavelength, and
- total Loss Budget = splice loss budget + connector loss budget + length loss budget.

Provide loss budget calculation equations on test form to be submitted as part of the documentation requirements. Provide threshold calculations described above along with measured results.

4.14. **Training.** Conduct a BISCI or IMSA certified training class (minimum of 16 hr.) for up to 10 representatives designated by the Department on procedures of installation, operations, testing, maintenance and repair of all equipment specified within this specification. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer Include the following training material:

- NESC, NEC, and ANSI/TIA 590 code compliance,
- fiber optic cable pulling and installation techniques,

- use of installation tools,
- splicing and terminating equipment and test instruments,
- trouble shooting procedures, and
- methods of recording installation and test data.

4.15. **Warranty.** Provide a warranty for all materials furnished in this Item. Ensure that the fiber optic cable, the splice enclosures, splice centers, and cable markers have a minimum of a 2 yr. manufacturer's warranty and that 95% of that warranty remains at the date of final acceptance by the Engineer. If the manufacturer's warranties for the components are for a longer period, those longer period warranties will apply. Guarantee that the materials and equipment furnished and installed for this project performs according to the manufacturer's specifications.

Ensure that the manufacturer's warranties for off-the-shelf equipment consisting of splice enclosures, splice trays, connectors, fiber jumper cables, and fiber patch panels are fully transferable from the Contractor to the Department. Ensure that these warranties require the manufacturer to furnish replacements for any off-the- shelf part or equipment found to be defective during the warranty period at no cost to the Department within 10 calendar days of notification by the Department.

Ensure that the manufacturer's warranty for fiber optic cable is fully transferable from the Contractor to the Department. Ensure that the warranty requires the manufacturer to furnish replacement fiber optic cable found to be defective during the warranty period at no cost to the Department within 45 calendar days of notification by the Department.

5. MEASUREMENT

Fiber optic cable installed, relocated and removed will be measured by the linear foot. Fiber optic splice enclosures, rack mounted splice enclosures and fiber optic patch panels will be measured by each unit installed. Splicing of Fiber Optic Cables will be measured by each fusion splice performed.

6. PAYMENT

6.1. Furnish and Install.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Cable" of the various types, and number of fibers specified. This price is full compensation for furnishing and installing all cable; for pulling through conduit or duct; aerial installation; terminating; testing; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Splice Enclosure" of the various types and "Rack Mounted Splice Enclosure." This price is full compensation for furnishing and installing all enclosures whether aerial, underground, in cabinet or in building; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Fusion Splice" for each fusion splice shown on the plans and performed. This price is full compensation for splicing; testing; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Fiber Patch Panel” of the various types and sizes specified. This price is full compensation for furnishing and installing all patch panels and terminating fibers on the panel as shown on the plans; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

Conduit will be paid for under Item 618, “Conduit” and Special Specification 6016, “ITS

Multi-Duct Conduit.” Electrical conductors will be paid for under Item 620, “Electrical

Conductors.”

6.2. **Install Only.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit bid price for “Fiber Optic Cable (Install Only)” of the various types, and number of fibers specified. This price is full compensation for installing fiber optic cable furnished by the Department; for pulling through conduit or duct; aerial installation; terminating; testing; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

Conduit will be paid for under Item 618, “Conduit” and Special Specification 6016, “ITS

Multi-Duct Conduit.” Electrical conductors will be paid for under Item 620, “Electrical

Conductors.”

6.3. **Relocate.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Relocate Fiber Optic Cable.” This price is full compensation for relocating all cable, regardless of cable size; for pulling through conduit or duct; aerial installation; terminating; testing; and for materials, equipment, labor, tools, documentation, and incidentals.

6.4. **Remove.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Remove Fiber Optic Cable”. This price is full compensation for removing all cable for salvage, regardless of cable size; testing; returning to the Department; and for materials, equipment, labor, tools, documentation, and incidentals.

END OF DOCUMENT